BULLETIN OF THE
Southern California Academy of Sciences

LOS ANGELES, CALIFORNIA

VOL. XLVI JANUARY-APRIL, 1947 PART 1

CONTENTS

Issued June 12, 1947

Southern California Academy of Sciences

Bulletin, Southern California Academy of Sciences
VOLUME 46 - - - - - - - - - PART 1, 1947

FEATHER WORKING AMONG THE AZTECS

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When the Spaniards invaded Mexico in the early part of the 16th century they found many things to intrigue their interest, not the least of which were gold smithing, wood carving, the mosaic art (the inlay of turquoise, jade, shell, etc., upon wood, shell, gold, etc.) and the delicate art of featherworking.

Said Bernal Diaz del Castillo, an eyewitness of the conquest, "Let us go on and speak of the skilled workmen Montezuma employed in every craft that was practised among them. We will begin with the lapidaries and workers in gold and silver and all the hollow work, which even the great goldsmiths in Spain were forced to admire, and of these there were a great number of the best in a town named Atzcapotzalco, a league from Mexico. Then for working precious stones and chalchiuites, which are like emeralds, there were other great artists. Let us go on to the great craftsmen in feather work, and painters and sculptors who were most refined; then to the Indian women who did weaving and the washing, who made such an immense quantity of fine fabrics with wonderful feather work designs; the greater part of it was brought daily from some towns of the province on the north coast near Vera Cruz called Cotaxtla."[1]

Although the other arts were well advanced, the Aztecs themselves prized that of featherworking above all others. As Clavijero said:

"Nothing was held in such high esteem among the Mexicans as the mosaic work which they did with the most delicate and beautiful plumes of the birds. For this purpose they raised many species of the beautiful birds with which those regions abounded, not only in the palaces of the kings, where the birds were kept, as we have already said, along with all kinds of animals, but also in particular houses, where, at certain times of the year the birds were plucked of their feathers to be used in that work or sold in the open market. They preferred those marvelous little birds which they called *huitzitzilin*, and the Spaniards called *picaflores* (hummingbirds), not only for their beauty but for their fine quality and variety of colors."[2]

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1. Del Castillo, Bernal Diaz The Discovery and Conquest of Mexico 1517-1521, edited by A. P. Maudslay, Harper and Bros., N. Y. 1928, pp. 295-296.
2. Terreros, M. Romero de, Las Artes Industriales en La Nueva Espana, Mexico, 1923, pp. 195-196.

The Indians used feathers to adorn a great variety of objects. Hours were spent in selecting, trimming, and placing these feathers in the proper place. As Clavijero further remarked:

"Each workman was charged with some portion of the work, and they took such pains with it and applied themselves with such patience to it that one might occupy the better part of an entire day trying to place one feather in its proper position, trying successively, many times to find the spot which would best suit it."[3]

Cortes and his men were greatly impressed by the great variety and the richness of the feather work they encountered among the Indians. Among the first gifts sent to the Great Captain by Montezuma were "ten loads of white cloth made of cotton and feathers . . wonderful things to see."[4] And, as Cortes neared Mexico City. Montezuma went out to meet the Spaniards and dismounted from his litter to stand beneath "a marvellously rich canopy of green coloured feathers with much gold and silver embroidery and with pearls and chalchiuites suspended from a sort of bordering, which was wonderful to look at."[5]

Later, after Cortes had sacked the city of Mexico, then known by its Aztec name Tenochtitlan, he sent home to Spain great quantities of treasure included in which were many elaborate creations of the featherworker's art. For example, in a box "For Our Lady of Guadalupe," was:

"First, a piece of feather-work like a cape, the center green and the border of long green plumes, the neck part worked with gold and blue feathers, lined with a tiger skin.

Item: a corslet of blue feathers and gold, open at the breast, like those used in sacrificial ceremonies, as customary here, with a girdle of green feathers.

Item: a shield, with a field of blue, with a man figured in the center wrought of gold.

"For the Monasterio de las Cuevas de Sevilla"

"A piece of featherwork of red feathers, the center and the neck part blue and red, with some gold, and in the field are strewn some ears of corn, with the border of green feathers and gold.

Item: a red shield with a blue field, and in the middle a head of gold from which emanates shining lights."[6]

There were literally hundreds of these feathered objects, shields, capes, fans, standards and head gear, as well as feathered reproductions of birds ornamented with gold, turquoise and jade. In one box alone were seventy-two shields worked in green feathers and ornamented with gold. These magnificent treasures went into the monastaries and churches of Spain, they were distributed

3. Terreros, id. p. 196.
4. Bernal Diaz, id. p. 120.
5. Bernal Diaz, id. p. 272.
6. Saville, Marshall H. *The Goldsmith's Art in Ancient Mexico*, Indian Notes and Monographs, Mus. of the Amer. Ind. N. Y. 1920, p. 56-101.

among the nobility of the Spanish court and of course a fifth of the entire amount of the glittering avalanche poured into the coffers of his Majesty, the Emperor, Charles the Fifth of Spain. Of all these thousands of feathered articles and the untold quantities of gold, silver, turquoise and jade, but a handful of specimens have survived to the present day. The gold was ruthlessly torn from the feathered background and tossed into the melting pot while the exquisite feathered pieces made good feasting for the moths.

As a result of all this vandalism our only knowledge of this virtually "lost art" of feather working, as well as of the many beautiful specimens which came from the dextrous fingers of those brown skinned artists of four centuries and more ago, is to be found in the records left by the master thief, Cortes, and his followers. Likewise, here and there, stray items may be gleaned from the accounts which were written by more sympathetic and scholarly contemporaries of the looters, the religious, who went into Mexico during and immediately after the conquest.

First hand information concerning the techniques of manufacture of the feathered objects is also derived from the few existing specimens of the craft which are preserved in Europe and in Mexico.

The longest, most detailed record of the manufacture of this featherwork is to be found in the work of that incomparable student of Aztec ethnology, the reverend Fr. Bernardino de Sahagun, who compiled his "Historia General de las Cosas de Nueva Espana" over a period of years during the early part of the 16th century. Sahagun was one of nineteen friars who came to Mexico in 1529, just eight years after the conquest. Thenceforth he lived in Mexico until his death sometime in 1590.[7]

The feathers used in the production of the many beautiful objects which came from the hands of the Aztec artisans were obtained largely as tribute from various subject towns of Montezuma.

These communities were required to send into the capital city of Tenochtitlan, thousands of bundles of feathers of all kinds as well as hundreds of complete bird skins and an occasional live bird, each year. The total valuation of these raw products ran into the neighborhood of $50,000 annually.

For example in 1518 the tribute rolls of Montezuma list the following towns as the principal contributors to the feather supply:[8]

The ten villages from the rich province of Soconusco. Likewise the pueblos of Coaixtlahuacan, Texopan, Tamazolaplan,

7. Sahagun, Fray Bernardino de, *Historia General de las cosas de Nueva Espana*, 5 vols., edited by Dr. Eduardo Seler, Editorial Pedro Robredo, Mexico, D. F. 1938, vol. I.

8. Penafiel, Antonio, Monumentos del Arte Mexicano Antiguo, vol. 2 Pt. 2 Berlin MDCCCXC, p. 92, Book of Tributes of Montezuma, copied from original in Lorenzo Boturini Coll.

Yancuitlan, Tepuzcululan, Nochesztlan, Xaltepec, Tamazolan, Mictlan, Coaxomilco and Cuicatlan produced some 800 handfuls of quetzal tail feathers valued at $2400.

The towns of Tlachquiauhco, Achiotlan and Tzapotitlan sent in 400 handfuls of quetzal feathers.

From the villages of Tochtepec, Xayaco, Otatitlan, Cozamaloapan, Mixtlan, Michapan, Teopantepec, Michatlan, Teotitlan, Xicaltepec, Oxitlan Tzinacanoztoc, Tototepec, Chinantlan, Ayotzintepec, Cuezcomatitlan, Poctlan, Teteutlan, Tlacotlala, Tzotlan, Yautlan and Yxmatlan, Montezuma demanded 80 handfuls of quetzal feathers 8000 handfuls of green plumes, 8000 handfuls of red plumes, 8000 handfuls of blue plumes and 4 handfuls of small colored feathers.

Other towns contributed insignificant amounts of feathers. The grand total for one year from the towns already listed amounted to 3280 handfuls of quetzal (tail) feathers; 9600 handfuls of green feathers; 1600 handfuls of yellow plumes; 9600 handfuls of red feathers; 9600 handfuls of blue plumes, 24 handfuls of miscellaneous colored feathers and 320 complete humming bird skins.

The monetary value of these plumes was estimated to be $51,612, no insignificant sum when one considers the prices of such things in the 16th century.

Antonio Vasquez de Espinosa in his work "Compendium and Description of the West Indies" written during the early decades of the 17th century and published as Vol. 102, Smithsonian Miscellaneous Collections, Washington, 1942 by Charles Upson Clark, contains the following passage on the feather working in Michoacan, Mexico (pp. 173-174, entry No. 490):

"They (the Tarascan Indians) work not only in wood but in paintings of featherwork, done with great dexterity and neatness, with feathers from the (many) beautiful birds of various colors which they have in this province, and in particular from a tiny bird which the Indians utilize for their feather paintings, because it has such unusual colors. This little bird is called vicisilin, and is a natural curiosity. It flies about for 6 months of the year—spring and summer—and when it recognizes the approach of winter, it drives its bill into a certain tree and remains imbedded there all winter without eating and immovable as though dead; but when it feels spring coming, it returns to life again, disengages itself from the tree, and flies off; this strange habit should give the philosophers food for speculation."

Concerning the last statement I should say the peculiar habits of the bird should also give the ornithologists food for speculation. It would seem that some Indian informant was pulling the leg of the pious old historian.

The featherworkers among the Aztecs were called *amantecas* and these craftsmen enjoyed special privileges. After the conquest of Mexico the art of feather working began to decline. The

Aztecs, no longer a great power, ceased to maintain large standing armies, consequently there was no further need for the thousands of shields, battle standards, cotton quilted armor head dresses, head plumes, etc., all of which were ornamented with feathers.

The Spaniards, on the other hand, placed orders to some of the more skilled workers for "souvenirs" in the shape of leather adargas or shields, of the type the invaders had brought in from Spain, to be covered with feather pictures. Here was a distinct departure from the styles of the ornamentation of the Aztecs. The subject matter on these shields consisted of European battle scenes but the technique employed in making these pictures was that used in prehistoric times. One of these shields made toward the end of the 16th century depicts the triumph of the Spaniards over the Moors in 1212 A.D. as well as other important battles waged during the 15th and 16th centuries. This shield is now in the Real Armeria de Madrid.

Religious pictures and religious vestments for use in the Catholic churches were also produced by the *amantecas.*

One of the best of the religious pictures is that of the Divine Savior fabricated sometime during the 16th century and now preserved in the National Museum of Mexico City. It represents the Christ seated with the right hand raised in the conventional style and holding a heart surmounted by a cross in the left hand. This entire picture, with the exception of the halo, which is of thin beaten silver now so deeply oxidized that it is almost black, is made of feathers laid upon a cloth background.

In Europe there are two mitres, exactly alike, one in the Pitti Collection in Florence, Italy, the other in the Monastery of the Escorial, in Spain. These are elaborate feather pieces gorgeously done in brilliant feathers and gold, covered with scenes of a religious nature.

Other religious pictures bear such subjects as San Antonio de Padua done during the 17th century; an unnamed picture in the "Musee de l'Homme," Paris, France and the "Mater Dolorosa," an 18th century picture now preserved in the University of Puebla, in Mexico.

As might be expected, when the creative urge supplied by the social and religious customs of the Aztecs, began to fade, the quality of workmanship and methods of manufacture also began to deteriorate.

As a result, the art during the 18th century was on the decline. The pictures were no longer composed entirely of feathers. European artists drew faces, hands and feet of the figures while the Indian craftsmen finished the rest of the work in feathers. As time went on, common lithographs served as a base and the use of feathers grew less and less.

The art of featherworking suffered its death blow in the 19th century. By this time practically all of the small pictures were being done over colored lithographs. A few bird figures and

occasionally other emblems were done entirely in feathers and show in a minor way the careful workmanship which once characterized this great art. Examples of this type of work are to be seen in the representations of feathered birds which are a part of the Coronel Collection in the Los Angeles County Museum. Here too is a replica of the Mexican coat of arms also done in bright feathers.

On the whole however the best of the later day featherworking was done during the last half of the 19th century. The last of the old-time *amantecas* was still practicing his craft at Patzcuaro during the close of the 19th century. Today, one sees only vestigial remnants of the art in the cheap postal cards sold in curio shops throughout Mexico and in some parts of the United States.

But let us now turn to the processes of feather working as described by Sahagun, mentioned in the forepart of this article. This is the only detailed account which we have and hitherto it has been published only in the Spanish or the Aztec languages. With the assistance of Miss Barbara Loomis I have translated it from the Spanish edition of Sahagun edited by Dr. Eduardo Seler.[10]

CONCERNING THE INSTRUMENTS WITH WHICH THE FEATHER ARTIZANS WORK

1. Here are enumerated the different instruments of the featherworkers: the little copper hoe, the copper knife for cutting the feather.

2. And the bone smoother with which the feather is put into place.

3. And the brush, the box of colors with which they first outline and then paint their picture.

4. And the block of wood, the tablet upon which the feather is cut.

5. They use with the copper implement a sheet of very hard, red wood.

6. This work in feathers has progressed from Montezuma's time onward.

7. Because it was in the period of his reign that the art grew and the importation of quetzal and other precious feathers was augmented.

10. Sahagun, Bernardino de, Fr., Historia General de las Cosas de Nueva Espana, 5 vols. Translated and edited by Dr. Eduardo Seler, Editorial Pedro Robrero, Mexico City, 1938. vol. V, pp. 217-249.

8. And the king lodged the feather workers in separate quarters within the town.

9. He gave one house to the workmen who were "his workers in special feathers" (that is to say featherworkers for the god *Uitzilopochtli*) a common term which denoted the feather working artizans of the communities of *Tenochtitlan* and *Tlatcloco*.

10. The latter workmen alone fashioned the garments worn by *Uitzilopochtli*, called *teoquimitl* (mantle made of the precious bird plumes, that is to say feathers of the roseate spoonbill; *quetzalemitl* (mantle of green feathers from the quetzal bird); *uitzitzilquemitl* (mantle made from the humming bird feathers; *xiuhtotoquemitl* (mantle of turquoise colored feathers from the Cotinga); all sorts of lavishly decorated garments and pictures made with all kinds of valuable plumes.

11. And (the other feather workers) made the garments which were the property of Montezuma, which the latter was accustomed to present as royal gifts to his guests, the head men of the smaller towns.

12. From which they derived the name of featherworkers for the palace, artizans of the king.

13. And others were called featherworkers of the storehouses; they were employed in the various storehouses of the king Montezuma.

14. The latter workers made the dance costumes for the king Montezuma who wore them at the dance.

15. The day of the fiesta they made him select for his pleasure the garment which he wished to wear at the dance.

16. Thus the employees of the different royal warehouses made all sorts of garments and guarded them in the warehouses.

17. And others were called home feather workers. The latter were occupied solely in the manufacture of heraldic devices for the chiefs and warriors and they dealt with them commercially; now it was a shield or a coat of armor made with yellow feathers, or some such object which they made.

18. And even when there was no longer any great need for the feathered insignia, the industry and ornamentation (of feathered objects) continued and thus were preserved the same techniques which the ancient founders of the feather working industry had originated and whose artistic ability is recognized (to the present time).

19. So it is today that the worker continues his profession with much skill and through long experience.

20. If anyone has a need of them they still make, cover and beautify shields with feathers.

21. They make all of the insignia which they wear on the back at the dance and all of the dance costumes, the various trappings used in the dance and the finery with which they are trimmed, the head ornaments, the forehead bands, the arm bands and bracelets, the fans made of the royal heron feathers, red spoonbill, turpial, Indian turkey, and quetzal; and the standards carried in the hand, made of green quetzal plumes alternating with the yellow feathers of the turpial much in the same manner as the joints of the finger alternate with each other; the standards made of the royal heron plumes and those made out of a plate of gold or of silver and crowned with a tuft of quetzal plumes.

22. And it is in the feather mosaics particularly that the skill of these artizans is displayed, for these images are the true works of feathered art.

23. And by two different modes are brought out the skill of the workman in the art of featherworking.

24. The first method of working consists in fixing the plumes, with paste, upon a background, thus is this work done.

25. The second methods of executing the work consists in finishing the task by means of fine thread and cloth.

26. Here are given the first steps in beginning this work when the featherworkers undertake a task.

CONCERNING THE MANNER IN WHICH THESE MEN DO THEIR WORK

27. The featherworkers who make the mosaics of bird plumes and whose task it is to construct all types of this work begin in the following manner:

28. In the first place they study how they shall lay out their sketch.

29. They are the painters who make the outlines.

30. When they have received the sketch and they are assured that it is in sufficient detail.

31. They lay upon a maguey leaf a thin layer of cotton and flour paste, called a cotton base.

32. They first obtain a good white maguey leaf, one that has a smooth surface, clean and without any scabs, all parts of the surface must be equally smooth and without cracks in order that the cotton base may be prepared upon it.

33. For the first step they give the maguey leaf a coating of paste.

34. Afterward they place upon it carded cotton, they straighten the filaments and fix them in place.

35. Before fixing the cotton upon the maguey, they card it well, they refine it carefully until it resembles a spider web or a wisp of cloud.

36. They expose it to the sun; but they do not let it dry thoroughly, only for a very short time and superficially.

37. When it is dry enough, a second coating of paste is applied to the cotton paper and the surface is rubbed until it is very smooth and it is no longer necessary to card it and the paste is allowed to dry thoroughly.

38. And when it has dried well, to the point of curling, the paper is lifted from the maguey leaf.

39. After this is done, the paper is spread out there and the color sketch is planned and the outline is done in color, in such a manner that it becomes visible and appears upon the paper background.

40. And this having been done, the cotton paper is completely covered with the design and arranged without omitting any of the figures in the sketch, it is then fastened with paste upon a paper made of tree bark; duplicating and reinforcing the cotton and paste paper used as a base.

41. Presently the worker begins to cut with a copper trimmer, and lift out the painted pattern which covers the paper.

42. The pattern is cut out upon a little block of wood called a cutting board; upon this block are cut the various plumes, they are reduced to small pieces, trimmed and cut all around.

43. And when all parts of the master stencil are cut out in accordance with the painted sketch, it is placed upon a maguey leaf and the drawing is traced upon the leaf following the perforations in the master stencil.

44. The maguey leaf is painted, rubbed with paste, the cotton is spread upon it and thus by means of cotton and paste is made the cotton paper upon which will be placed the plumes which will make the outlines and modulations of colors.

45. And it is then placed to dry anew in the sun.

46. After this is done the common feathers, known as background plumes are laid upon it.

47. But this facing, this coating of background feathers is applied immediately and separately upon the maguey leaves.

48. The feathers are fastened together with paste, after which they are fastened to the maguey leaf (that is to say upon the cot-

ton paper which covers the surface of the leaf) and the feather background is smoothed out with a small comb or bone smoother.

49. All of the so-called background plumes are only ordinary feathers.

50. They facilitate the working of feathers in this way.

51. They compose the primary background and serve as a foundation or the various precious plumes.

52. For example they use as a pasted background the yellow dyed plumes, those of the royal heron, the rosey hued feathers of the *chamolin,* the blue tail feathers of the guacamayo, the ruddy ones of the papagayo *cocho,* those of the royal heron or any other solid or multicolored ones.

53. They select and place them carefully, knowing by experience and by comparison those which are the most valuable and those which should be arranged together and those which are the ones to best serve as a background.

54. To the turquoise colored plumes of the cotinga they assign a background of the blue tail feathers of the red guacamayo or arara; and (to bring out the colors), the shining (blacks and greens) of the tzinitzcan, they use the shaded plumes of the papagayo *cocho;* as a contrast for the plumes of the red spoonbill they use feathers from the smooth beaked bird of the same species or they use red feathers; and as a background for the resplendant yellow plumes they utilize feathers dyed a dull yellow, or left over feathers from the bird supplying the shining yellow plumage.

55. The plumes known as the yellow dyed ones are colored yellow artificially.

56. To make this color known as "cream of the plant" it is boiled over the fire with some alum, later potash is added.

57. As soon as the background of ordinary feathers has been applied so as to cover entirely the painted cotton paper which covers the maguey leaf, it is removed from the leaf.

58. And afterward a small block is used upon which the paper is secured with paste.

59. Once more the sketch is applied by means of the master stencil.

60. Upon this little block which serves as a firm foundation for the pasted feathers, the work is done.

61. Let us suppose that a flower picture is desired, or of plants, any object or any beautiful picture.

62. When the picture is outlined and painted upon the block, then commences the task of putting paste upon the plumes and arranging them in proper position.

63. In the first place the paste is mixed with and dissolved in water. The dissolving of the paste in water is the work of young boys, the apprentices. They make the solution for the master craftsmen.

64. After this is done the black is cut, the outline, with which the feather picture is outlined in black.

65. This then is the first thing that is done. First they smear with paste, the feathers which compose the outline, and these are fastened upon the background with a bone smoother.

66. They make the outline with the black feathers of the zorzal or of the *chamolin* or with the common feathers of the same *chamolin*.

67. After this comes the cutting of the feathers which comprise the first layer or covering, according to their quality, after which the work begins in accordance with the sketch.

68. Let us suppose they begin with the turquoise colored plumes of the cotinga, or the red spoonbill, or the topaz colored humming bird, or the blue humming bird, the common humming bird, the precious humming bird, the humming bird whose plumage is the color of fire.

69. In accord with the appearance of these various plumes, their burning brilliance, their luster, their companion feathers, those of the background, the more common feathers, are cut.

70. Thus is made to appear the sketch as it is painted (upon the paper) with all of its colors.

71. When the feather background is pasted and set in place with a bone smoother, the more valuable feathers are placed upon its surface, they are arranged there, they are tipped with paste and pressed into place with the bone smoother, moving always forward and covering the ordinary plumes that form the background, or base.

72. And the master paper stencil is always in use, checking to see that the work has not been changed in any manner, that no errors have been committed and that the stencil is in accord with all of the pasted feathers.

73. Thus is made and brought to perfection the feather picture which is made with paste.

74. There is another type of (feather) work which is done with thread and cloth. By this method they make the fans, those made of quetzal plumes, the feather arm bands, the insignia carried upon their backs, and the others, the yellow coats of mail, etc.; likewise the hangings, the feather tufts, the balls of plumage, the tassels with all of which they adorn and beautify the fans.

75. These works are done in the following manner:

76. First, the framework is made, afterward it is dressed and covered with cloth upon which the quetzal plumes are set in place.

77. And the quetzal feathers are placed in the following manner:

78. First, bamboo is fastened to the base and on the reverse side of the plumes, the feathers are tied to and reinforced with bamboo.

79. After this, thread is attached to them, they are tied round about, the bases of the feathers are secured with thread, cords are placed there in order that they may be strung together and made fast to the cloth base.

80. After the feathers are strung together, loops of very fine thread are fastened, like little handles, midway of the length of the feathers and are made fast there.

81. At last the quetzal plumes are well placed and arranged so that they do not become intermingled or spoiled but remain instead, in good condition, side by side.

82. And in the following manner are the quetzal plumes and the others strung together:

83. They are worked back and forth, from side to side; that is to say, if for example, on one side the feathers appear too far apart, or too close together, or if by chance they become intermingled or spoiled, then they are removed.

84. When the plumes are linked and laced together they are sewed to the framework.

85. Immediately upon completion of this work the covering of the plumes, the making of the bases begins.

86. If the brown and white feathers of the *Piaya cayana* or the yellow plumes of the turpial follow in order after the quetzal feathers, thread is fastened to them, they are strung together (in the cloth base), they are laced together (in the middle of their length) and afterward sewed upon the framework, their bases are fixed thereon with cloth and they are made to stay in place (on the framework) by means of the cloth.

87. In the same fashion one row of bicolored feathers, or possibly others (red ones) alternating with quetzal plumes is made, immediately a border of roseate spoonbill feathers is added and the whole is completed with some white, light down feathers attached to their bases.

88. Immediately this work is done and finished, another insignia is decorated, etc.

89. And if they desire to make some animal or some small creature, as a first step they cut branches from the *Erythrina corallodendron* and with them make the skeleton of the animal.

90. And if the fabrication of some very small creature is desired, such as a small lizard or the corn plant image, or a butterfly, the skeleton of the animal is made out of a dried corn stalk or with cut out pieces of paper.

91. Soon afterward a flour made out of the dried corn stalk is placed upon it, and they cover the paper cut outs with this flour mixed with paste.

92. Forthwith this figure is trimmed, it is flattened out, cleaned and smoothed.

93. And afterward it is covered with cotton paper and upon that is pictured, the feather mosaic, the sketch which it is supposed to represent and with which it will ultimately be covered.

94. After taking into account the animal it is supposed to represent, it is painted accordingly.

95. And some times they dispense with the copper cutter, the cutting board for the feathers, and the bone smoother.

96. They simply cut the feathers as they need them, paste them and arrange them with the bone pleater.

Thus do the featherworkers carry out their tasks.

The illustrations for this article have been drawn from the "Lienzo de Tlascala"[11] and the "Tribute Rolls of Montezuma."[12]
In redrawing these representations of feather standards, head gear, fans, shields, etc., I have attempted an ethnological reconstruction of the objects. The reconstruction is based upon the description of similar objects which now exist in the Vienna Museum of Ethnology (which include a fan, shield and headdress[13] and which were mentioned and described by Zelia Nuttall.
The reinforcing of the long feathers with bamboo strips, as described by Sahagun in the second process of featherworking, is confirmed by the Nutall study of the headdress or standard in the Vienna Museum. Concerning the latter item, Mrs. Nuttall describes it thus:

"It resembles somewhat a modern open fan and is composed of a firm, net-like fabric, woven with much accuracy and neatness, of finely twisted threads (probably of agave fibre), and stiffened by twenty-eight thin sticks covered with fibre and woven into the net at regular intervals. The quills of all the feathers (with the exception of those of the turquoise band) were so delicately and skillfully knotted to this net that the front, with its series of sharply defined symmetrical, concentric bands formed a closely covered, flexible texture of featherwork.

"The quills of the long quetzal feathers forming the broad, loose fringes, were also fastened to the net and were firmly caught in its meshes in no less than three places. Corresponding exactly on both sides, the radial width of the network and its concentric bands in front

11. *Codex Colombino,* included in *Antiguedades Mexicanas,* Mexico D. F. 1892.
12. Penafiel, id.
13. *Illustrated London News,* Sept. 5, 1931; Nov. 5, 1938.

is 28.5 cm. The central elevated portion measures 45 cm . being adapted to the support of the superimposed middle piece which is 32 cm. high from its base of attachment in front and 20-30 cm. wide. The semi-circular opening at the base, of special importance, is 15 cm. deep, measures 26 cm. across.

"The total width of the feather-piece is considerably increased by the fringe of quetzal feathers 52 cm. wide. This was held together by a series of loops of thread ultimately fastened to the projecting sticks visible above the central elevation. This centre, upon which additional strain was naturally thrown, was thoughtfully supplied with power to resist it. It was strengthened by a stiff lining of hide (presumably deer skin) and was also provided with an internal set of dexterously disposed sticks in addition to its radial stiffenings.

"Two thin sticks fastened diagonally across the radial ones, render it evident that for some special reason, as will appear later, a slight stiffening had been required at each side, whereas the central portion of the object was left flexible to be freely curved and adapted to varying size or shape. A loose piece of net, woven of thinner threads, now "completely torn," was stretched over the whole back of the feather-piece."

This feather headdress aside from being composed of bright green quetzal plumes and turquoise blue feathers was also ornamented with small, thin plates of gold.[14]

BIRDS USED BY THE AZTECS

Sahagun mentions some of the birds which were killed for their plumage. Dr. Eduardo Seler attempts to identify a few of these while Mrs. Nuttall also contributes additional data.

The quetzal which contributed the long green tail feathers, two to a bird, was slaughtered by the thousand each year, and if we are to believe the tribute rolls the total number must have been in the neighborhood of around 200,000 birds per year, or possibly more, depending upon the number of feathers which could be counted in a "handful." This bird was probably *Pharomachrus mocino de la Llave* of the trogan family. The quetzal was by far the most important bird used by the featherworkers in making head dresses, standards, fans, etc. Today it is the national bird of Guatemala, and is not too plentiful. It is quite possible that the continued slaughter of this creature during the days when the feathers were in such demand, over five hundred years ago is responsible for its scarcity today.

Another bird of brilliant plumage having turquoise blue feathers on the back and a purple breast known as the cotinga, is believed to be *Cotinga cincta* and *s. Cerulea.* The Aztecs called it *xiuhtototl.* They hunted it in the dense forests, along the coast, in the more temperate sections of the country and in the open spaces. Apparently the bird had a wide range of habitat. The natives killed it during the month of October, when the plums became rip , shooting it with blow pipes and darts or clay pellets. At the

14. Nuttal, Zelia, *Standard or Head-Dress?* Arch. and Eth. Papers, Peabody Mus. vol. 1, no. 1, Cambridge, Mass., pp. 5-47, with 3 pl., Oct. 1888.

present time the bird is plentiful in Brazil and the natives hunt it while it is feeding upon the fruits. In Mexico the favorite dwelling place of the cotinga now is along the southern sea coast. The tribute rolls indicate the skins of this bird were obtained from the provinces of Chiapas and Soconusco.

The *cacuan*, the bird of rich plumage described by Sahagun is the turpial (*Icterus gularis Wagl*). Its feathers above are red, the tail feathers are yellow and black while the rest of the body is covered with duller, tawny colored plumage.

The chamolin had reddish colored plumage so deep that it verged upon black.

Sahagun described the papagayo with a reddish colored head, a yellow beak and body plumage purplish red. The wings on the upper surfaces were deep red mixed with yellow. It is believed that this bird is *Pionus senilis*.

The *Piaya cayana L.* is believed by Seler to be the bird which supplied the long tail feathers banded with white and brown.

The bird known as the "quechol rojo" is believed by Seler to be the spoonbill (*Ajaia ajaja L.*).

Then too there were many kinds of humming birds used the tiny, brilliant feathers being considered among the most precious for delicate shading of colors.

Unfortunately we cannot identify all of the varieties of the *huitzitzilin* or humming bird. So it is with many others birds which were used by the old *amantecas*.

At the present time, out of the hundreds and thousands of feathered objects produced in the workshops of Montezuma and his forebears but a scant handful remain to give us the barest inkling of the glory that was Nahua, the land of the Aztec.

The known items of featherwork, in addition to those already listed include a feathered cloak in the Musee du Cinquantenaire at Brussels, Belgium, made of red plumes over one meter in length and garnished with a border of red, black and blue feathers.

In the Royal Museum of Berlin is a beautiful example of a feathered mantle over a meter in length. The base of this piece consists of paper and a coarse tightly woven cloth. It is covered with feathers of different colors and is divided in the center by a band of red feathers. The upper part of the cloak is done in green feathers of the parrot, the common *papagayo* of Mexico from the hot country. In the center is a hieroglyph representing *chalchiuitl*, a precious green stone done in green, white and red feathers. The lower half of the mantle has as its central motif a human skull done in white feathers superimposed upon a design in blood red feathers. Other feathers, green, black, and yellow add their colors to the feather garment.

There are two fine feathered shields in the Royal Museum of

Stuttgart, Germany (*Museum fur Lander-und-Volkerkunde*) and one very poor specimen in the *Museo Nacional* in Mexico City.[15]

A more recent discovery of a fine feathered plaque done in yellow, blue, red and black feathers, the design representing a whirlpool of water done in blue humming bird feathers upon which, superimposed in red and yellow, is the symbol of a maguey thorn, sacrificial symbol and a design representing a tilled field. The whole is a name glyph of some village.

This colorful disc of pasted feathers was found concealed beneath the cotton cloth and deerskin lining of sixteenth century chalice case, hidden there, no doubt, by some Indian who wished to preserve this bit of native grandeur.[16]

Thus, counting this last discovery, there are but ten examples of prehistoric Aztec featherwork in existence at the present day. There are, of course, many more examples of the feather art produced during the late 16th century and continuing on into the 19th and early 20th centuries, few of which however equal in beauty or craftsmanship the creations of the *amantecas* of Montezuma's palace.

15. Sahagun, id. pp. 235-239.
16. Granados, Rafael Garcia, *Mexican Feather Mosaics*, Mexican Art & Life, January 1939, Mexico D. F. pp. 1-4. (This item contains seven plates of reproductions of prehistoric and historic featherwork.)

PLATE 1

A. Feather shield with the *jicara tuerta* or twisted gourd design symbolic of water done in blue and gold. The background feathers were sewed upon a cloth and buckskin base, which covered the bamboo and hemp fibre cord shield proper.

B. Reverse side of shield showing bamboo rod foundation laced together with hemp cords. Hand grip consists of two leather straps sewed to skin or cloth pad upon which knuckles of right hand rested.

C. Detail of shield foundation showing bamboo rods partially covered and the cloth and skin foundation laced to face of shield. Sketch indicates reverse side of shield.

D. Warrior armed with feather shield, cotton quilted armor and obsidian edged maquahuitl. Upon his back is a feather standard with a bamboo or thin wooden slat framework upon which is sewed a cloth or paper foundation covered with feathers.

(Sketches A, B, C, reconstructions by the author based upon original Aztec drawings and descriptions. D is a sketch elaborated upon a Tlascalan drawing in the 16th century "Lienzo de Tlascala").

PLATE 1

PLATE 2

A. Feather standard carried by a warrior. Plumes are tied to a base of coarse cotton cloth which in turn is sewed upon a bamboo framework.

B. Another type of warrior's feather standard which was strapped to the back.

C. An Indian sketch depicting a live eagle given as tribute to Montezuma. (After the Tribute Roll of Montezuma).

D. Reverse side of feather standard (A) showing the bamboo slat framework reinforcing the cloth and feather surface.

(All sketches except D are after original native drawings in the "Lienzo de Tlascala" and the Tribute Roll of Montezuma. D is a reconstruction of A based upon 16th century descriptions and existing specimens in Vienna Museum.

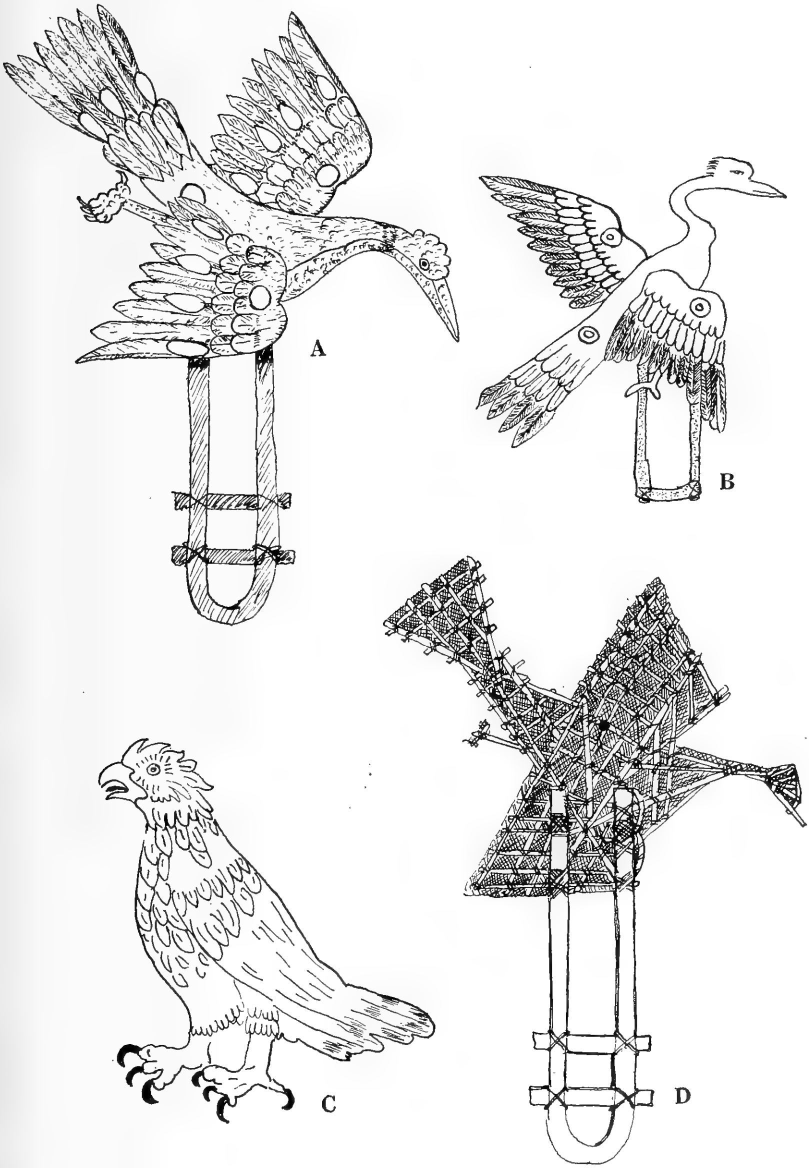


PLATE 2

PLATE 3

A. This is a "*penacho*" or head plumes of a special type, known as *quetzaltlalpiloni.* It was originally destined as a gift for Montezuma, who in turn probably gave it to some headman as a token of friendship.

B. A hieroglyph from the "Tribute Roll of Montezuma," representing a tribute of 80 birdskins of a certain kind. Each little "flag" corresponds to the numeral 20.

(After a drawing in the Tribute Roll of Montezuma).

C. Warrior wearing the *quetzaltlalpiloni* as depicted in A. (Sketched after Lienzo de Tlascala). Note the *bezote* or lip plug, probably of gold and jade protruding from lower lip of warrior.

D. A hieroglyph representing 400 handfuls of *quetzal* tail feathers. Since each *quetzal* contributed only two tail feathers, one can readily imagine the terrific slaughter of these rare birds that went on year after year. The little "tree" is the Aztec symbol for 400. (After a sketch in the Tribute Roll).

E. Warrior wearing a cloth or skin helmet ornamented with feather plumes and short, trailing, feather ropes. (After the Lienzo de Tlascala).

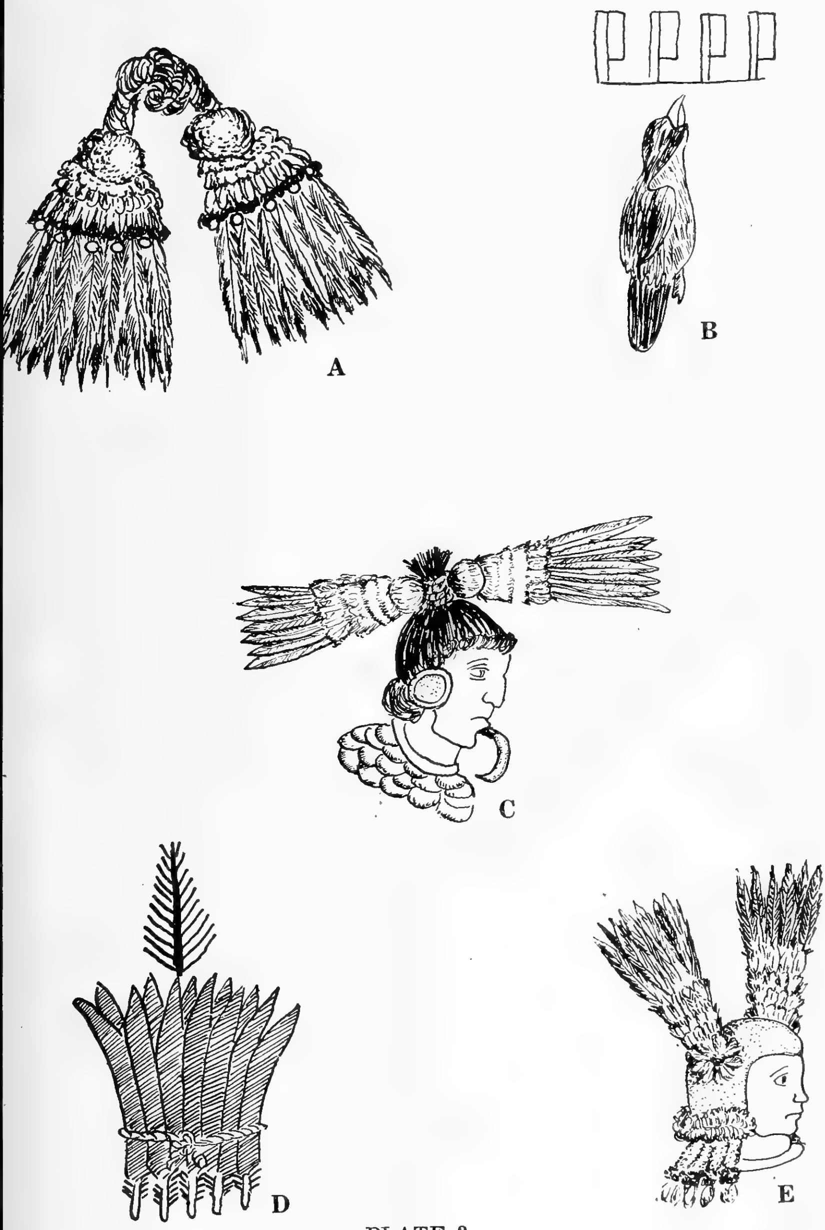


PLATE 3

PLATE 4

A. Feather fan of green quetzal feathers with inner circles of red, yellow and blue feathers. Center motif is small feather butterfly. Spokes and handle are of wood with gold plates. (After a specimen in the Vienna Museum).

B. A feathered back standard carried by Aztec warriors. Outer feathers are green quetzal tail plumes. Others are yellow, pink and a center of fluffy golden feathers. Thin flat gold ornaments are applied to the feathered surface. The base is bamboo splints and a thin slat framework. (After Lienzo de Tlascala).

C. Warrior wearing a semi-stiff head dress with central plume of feathers fastened to a wooden spindle. Feathers are probably reinforced with thin bamboo splints down mid-rib of each stand-up feather. Gold nose ring and gold and jade lip plug. (After Lienzo de Tlascala).

D. Feather back standard on base of bamboo and cloth. Large plumes are from tail of *quetzal*. Small oval plates are of gold. (After Lienzo de Tlascala).

E. Elaborate standard carried on back of Aztec or Tlascalan warrior. Upper portion may represent a monkey and is probably done in cloth and feathers over a light cane framework. The entire insignia is covered with feathers, probably mounted on cloth base attached to bamboo splints. (After Lienzo de Tlascala).

F. Standard similar to D.

G. Tlascalan warrior equipped with feather shield and *maquahuitl*. On his back is a simpler form of standard consisting of a piece of hide or paper probably reinforced with bamboo splints and surmounted by an elaborate *penacho* of quetzal tail feathers with lesser feathers in yellow, red and white. (After Lienzo de Tlascala).

H. A head plume mounted upon a thin wooden spindle with the twisted red and white cotton or soft deerskin head band, similar to the ensemble worn by warrior in G. (Lienzo de Tlascala).

I. Standard, more elaborate but similar to one shown in G.

PLATE 4

PLATE 5

Here are depicted a number of type standards either carried upon the back or in the hand. These were made of feathers, cloth, paper and bamboo united with stout hemp or maguey fibre thread. Of these banners Bernard de Castillo said: "Each company had its device and uniform, for each Cacique (leader) had a different one, as do our dukes and counts in our own Castile." The poles were usually lashed firmly to a thin framework of bamboo splints or wood and this in turn was fastened to the back of the warrior by means of two narrow leather bands that crossed on the chest. Figs. E and F are a bit different than the others. Fig. E illustrates a type standard sometimes carried in the hands. F is apparently a rope of fluffy feathers similar to a feather boa worn by European women during late 19th and early 20th centuries. (All after Lienzo de Tlascala).

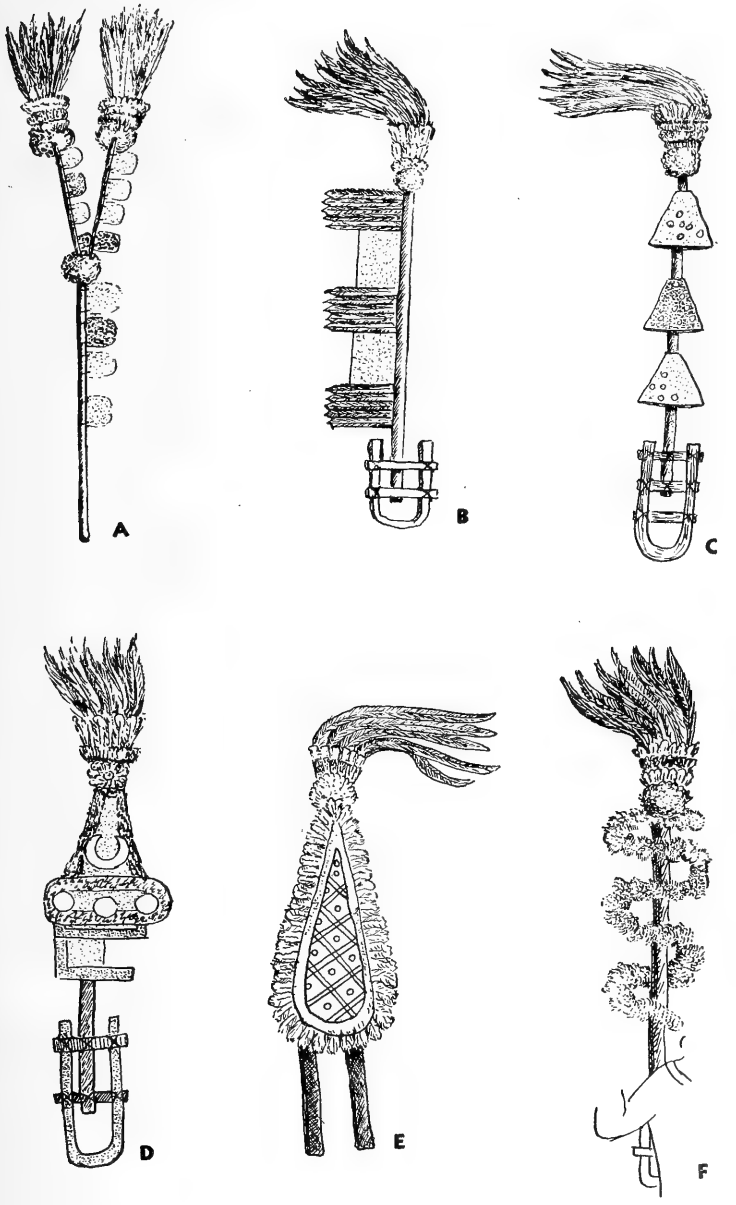


PLATE 5

A STATISTICAL STUDY OF THE METAPODIALS OF THE DIRE WOLF GROUP

FROM THE

PLEISTOCENE OF RANCHO LA BREA

BY

JOHN O. NIGRA AND JOHN F. LANCE

Introduction

Although many features of the Rancho La Brea Pleistocene occurrence are known to every student of vertebrate paleontology, much material has remained virtually untouched or has received little study since the time of the excavations. This is unfortunate inasmuch as the large numbers of individuals of certain forms offer opportunities for faunal studies rarely found when dealing with fossil collections. A striking example is furnished by the remains of the dire wolf group.[1]

While the dominant canine species from the asphalt is *Canis* (*Aenocyon*) *dirus*,[2] smaller extinct forms, like the coyote (*Canis orcutti*) and the timber wolf (*Canis furlongi*) are also recorded. The coyote is known by a considerable number of individuals, but the timber or gray wolf has been identified by only eight skulls in the collection. Little work has been done on the skeletal elements of any of these species. The present paper gives the results of a study of the metapodials that were originally segregated and identified as belonging to the *Canis* (*Aenocyon*) group in the Los Angeles County Museum collection from the Pleistocene of Rancho La Brea. Among these metapodials are doubtless a small number belonging to the fossil timber wolf, since it has not been found possible to segregate them by morphological features.

Since the number of timber wolves, as established by a ready identification of their skulls, is negligible in comparison to the overwhelming number of individuals of the dire wolf group, considerable reliance may be placed on the statistical analyses of

1. The term group is used in the sense that it includes not only the typical dire wolves *Canis* (*Aenocyon*) *dirus*, but likewise those forms which, on the basis of skull or dental characters may be referred to *Canis* (*Aenocyon*) *milleri* from Rancho La Brea.

2. Stock, C,, J. F. Lance and J. O. Nigra, Bull. So. Calif. Acad. Sci,, vol, 45, pt. 2, pp. 108-110, 1946.

measurement data derived from the complete assemblage. Thus, analyses have been made to determine the arithmetic mean, standard deviation, and coefficient of variation in length of the fossil metapodials, and the standard errors involved in the derivation of these quantities. It is likewise possible to arrive at an estimate of the average sizes of the nine kinds of metapodials (metacarpals I, II, III, IV, V and metatarsals II, III, IV, V) of *Canis* (*Aenocyon*) from Rancho La Brea. These results are presented in a series of frequency curves and bar diagrams.

Certain features of the present investigation need further comment. Thus, the amount of fossil material utilized is far greater than that usually available to a paleontologist engaged in statistical studies. On the other hand, the samples treated in the analyses are by no means pure. Attention has been directed already to the probably small representation in the collection of metapodials of the timber wolf. As yet it has not been found possible to differentiate species within the dire wolf group on the basis of metapodials. Moreover, it cannot be asserted that only fully adult individuals are included, although the obviously immature bones are excluded from the samples. Both sexes are represented by the material, and the measurements of the metapodials are confined to longitudinal dimensions.

An average of approximately 1200 individual elements for each metacarpal and metatarsal, both right and left, were measured. Only in the instance of metacarpal I and the rudiment of metatarsal I, was the number of available specimens considerably smaller. In all, more than 20,000 bones of wolves from Rancho La Brea were measured.

ACKNOWLEDGMENTS

The writers wish to express their appreciation of the courtesy of the Los Angeles County Museum in permitting the loan of the large collection of extinct wolf metapodials. It is a pleasure to acknowledge the help of Dr. Chester Stock who suggested the problem and who has guided and assisted its investigation in several ways.

TABLE 1

MEAN, STANDARD DEVIATION, AND COEFFICIENT OF VARIATION OF METAPODIALS OF AENOCYON

Metapodial		Number	Mean in Centimeters	Standard Deviation in Centimeters	Coefficient of Variation
MC II	R	1163	7.70 ± .01	.31 ± .01	4.0 ± .1
	L	1219	7.72 .01	.33 .01	4.2 .1
MC III	R	1261	8.81 .01	.36 .01	4.1 .1
	L	1239	8.81 .01	.36 .01	4.1 .1
MC IV	R	1177	8.73 .01	.35 .01	4.1 .1
	L	1264	8.71 .01	.36 .01	4.1 .1
MC V	R	1298	7.39 .01	.32 .01	4.4 .1
	L	1268	7.38 .01	.33 .01	4.5 .1
MT II	R	1250	8.34 .01	.34 .01	4.1 .1
	L	1265	8.33 .01	.34 .01	4.1 .1
MT III	R	1283	9.41 .01	.38 .01	4.0 .1
	L	1249	9.40 .01	.39 .01	4.1 .1
MT IV	R	1239	9.63 .01	.39 .01	4.1 .1
	L	1220	9.62 .01	.38 .01	4.0 .1
MT V	R	1088	8.81 .01	.35 .01	4.0 .1
	L	1136	8.81 .01	.34 .01	3.9 .1

DISCUSSION OF STATISTICAL RESULTS

Although the largest specimens in the several series of metacarpals and metatarsals lie outside the expected limits of variation in length from the mean of a particular series measured, there is as yet no definite proof that they represent the timber wolf. It seems likely, however, that the largest metapodials, as well as a few of the longer bones within the normal distribution of measurements represent forms differing from *Canis* (*Aenocyon*) *dirus*. A graphical representation of the frequency distribution of the measurements of length of the metapodials assigned to the dire wolf group (see curves, figures *2* and 3) certainly suggests this, and it seems to be confirmed by the calculated standard deviation.

It is interesting to note that according to Merriam[3] "The *metarsals* like the metacarpals, are relatively somewhat shorter in the average specimen of *C. dirus* than in *C. pambasileus,* though

3. Merriam, J. C., Mem. Univ. Calif., vol. 1, no. 2, p. 239, 1912,

large specimens are present which exceed the largest measurements known in the latter form." It is not now known how many specimens of the modern timber wolf were available to Merriam in making this observation, but the assumption is that the number was not large.

Average lengths of metapodials.—Plate 6 gives graphically the mean lengths of metacarpals and metatarsals of *Canis* (*Aenocyon*). These results are based on approximately 1200 individuals of each element, except for metacarpal I. The latter was represented by approximately 250 specimens of each side. It will be noted that, with the exception of the first, each metapodial in the manus is shorter than the comparable element in the pes. The third metapodial is longer than the fourth, and the second is longer than the fifth in the manus; the reverse conditions prevail in the pes.

Frequency curves.—Curves showing frequency distribution of measurements of length of the metapodials of the dire wolf group are shown in Plates 7 and 8. These are grouped in the class intervals of original measurements. A coarser grouping would make these curves approximate more closely a normal distribution curve, but the presentation used suggests the presence of minor groupings within the series of bones studied. Sexual differences and the heterogeneity of the samples caused by the presence of timber wolf or other extraneous material are perhaps responsible. Study of additional skeletal elements may help to clarify this situation.

Considered as a whole, however, the results show that the total distribution approaches a normal one, and that the variation coefficient is relatively small. Simpson and Roe[4] state that the coefficient of variation for most such zoological data is between 4 and 10.

Calculations were made following the procedure suggested by Simpson and Roe. The arithmetic mean is the product of the sum of all observed values divided by the number of observations. The standard deviation from the mean is found by the formula

$$\sigma = \sqrt{\frac{\Sigma(d^2)}{N}}$$

where σ is the standard deviation, $\Sigma(d^2)$ the sum of the squares of individual variations from the mean, and N is the total number of observations. The coefficient of variation is an arbitrary ratio expressing the relationship of variation to absolute size. The coefficient here used is found from the formula

$$V = \frac{100 \quad \sigma}{M}$$

4. Simpson, G. G., and A. Roe, Quantitative Zoology, McGraw Hill Book Co., New York, 1939.

TABLE 2

AVERAGE SIZES OF METAPODIALS OF AENOCYON GROUP

Major Pits in Order of Greatest Average Yield

METAPODIAL	PIT 3 Mean length in cm.	PIT 3 No. of Spec.	PITS 61-67 Mean length in cm.	PITS 61-67 No. of Spec.	PIT 4 Mean length in cm.	PIT 4 No. of Spec.	PIT 13 Mean length in cm.	PIT 13 No. of Spec.	PIT 77 Mean length in cm.	PIT 77 No. of Spec.
MC II L	7.67	444	7.74	253	7.83	191	7.63	141	7.74	104
R	7.66	393	7.72	232	7.80	208	7.58	132	7.69	85
M	7.67		7.73		7.82		7.61		7.72	
MC III L	8.76	435	8.84	263	8.95	203	8.68	144	8.87	98
R	8.78	484	8.84	241	8.97	197	8.63	140	8.82	95
M	8.77		8.84		8.96		8.66		8.85	
MC IV L	8.67	437	8.72	264	8.78	214	8.55	150	8.72	96
R	8.68	402	8.74	242	8.84	214	8.58	134	8.74	80
M	8.68		8.73		8.81		8.57		8.73	
MC V L	7.35	427	7.40	221	7.49	210	7.24	147	7.39	140
R	7.35	455	7.40	242	7.50	210	7.27	146	7.40	114
M	7.35		7.40		7.50		7.26		7.40	
MT II L	8.29	405	8.41	285	8.43	219	8.20	153	8.38	115
R	8.32	435	8.37	262	8.46	190	8.18	157	8.33	94
M	8.31		8.39		8.45		8.19		8.36	
MT III L	9.37	416	9.43	268	9.51	228	9.25	146	9.34	85
R	9.35	481	9.43	262	9.62	193	9.25	162	9.44	81
M	9.36		9.43		9.57		9.25		9.39	
MT IV L	9.58	413	9.67	258	9.78	215	9.46	132	9.61	98
R	9.58	439	9.73	264	9.77	209	9.47	165	9.65	69
M	9.58		9.70		9.78		9.47		9.63	
MT V L	8.77	390	8.85	251	8.93	193	8.71	143	8.79	71
R	8.78	389	8.86	235	8.90	182	8.60	113	8.80	82
M	8.78		8.86		8.92		8.66		8.80	

where V is the coefficient of variation and σ and M represent standard deviation and mean respectively.

Standard errors have been calculated for these parameters. It should be noted that these values are based on the probability that the parameters of the sample represent the parameters of the total population, and are not related to errors in calculation or measurement.

Analysis of data with regard to individual Museum excavations.—A comparison of data on measurements of bones from different excavations indicates that the average lengths of the metapodials are not the same for all pits. The average length of these elements from pit 4 is greater than that of the metapodials from pit 13. The average length of the metapodials from pit 3 lies between the average lengths of those from pits 4 and 13. In this connection it is interesting to note that the largest number of metapodials recorded from the individual excavations at Rancho La Brea occurred in pit 3. An inspection of the data (table 2), which includes only the major pits, shows that the decrease in average sizes of the metapodials extends from pit 4 to pit 3 to pit 13, with pits 77 and 61-67 occupying intervening, but not consistent, positions.

California Institute of Technology,
Division of the Geological Sciences,
Contribution No. 397.

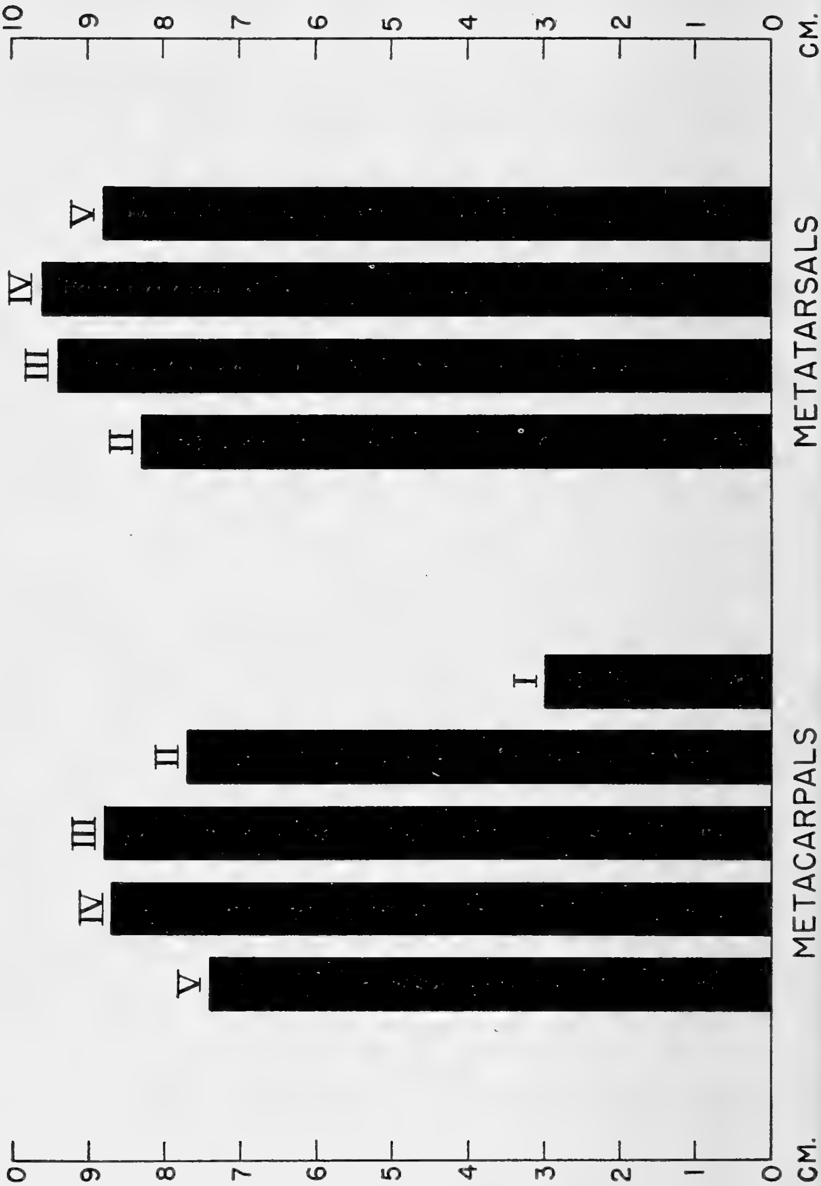


PLATE 6

Bar diagram showing relative proportions of metapodials in *Canis* (*Aenocyon*) group, drawn to natural scale. Left manus and right pes are represented, diagramatically, using mean values for each metapodial

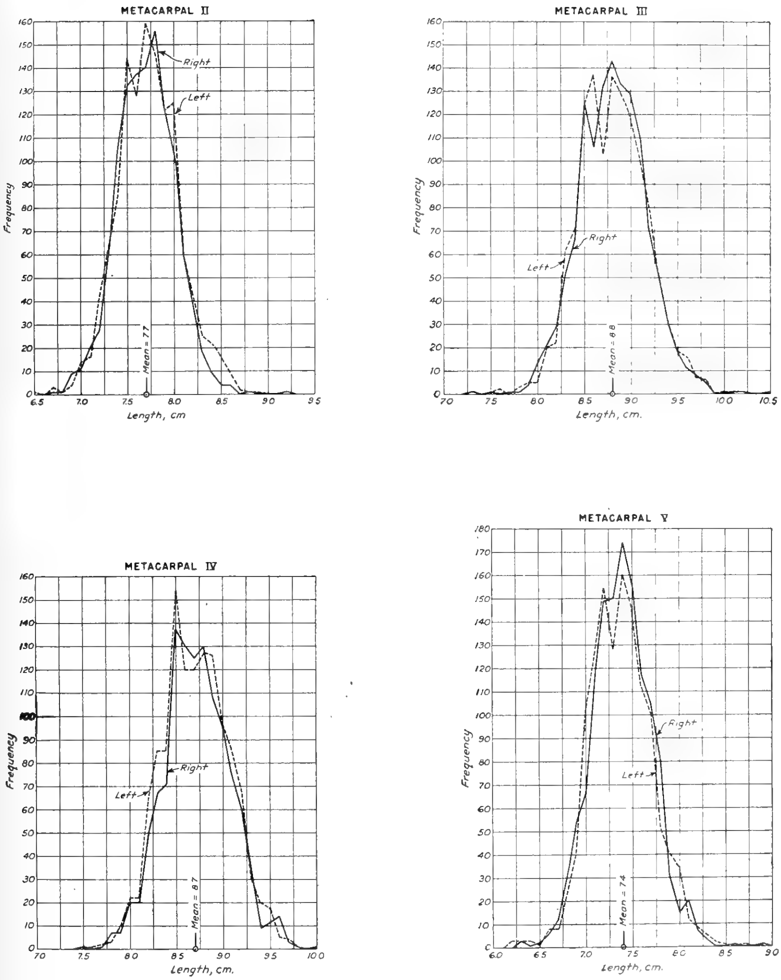


PLATE 7

Frequency distribution of lengths of metacarpals in *Canis* (*Aenocyon*) group

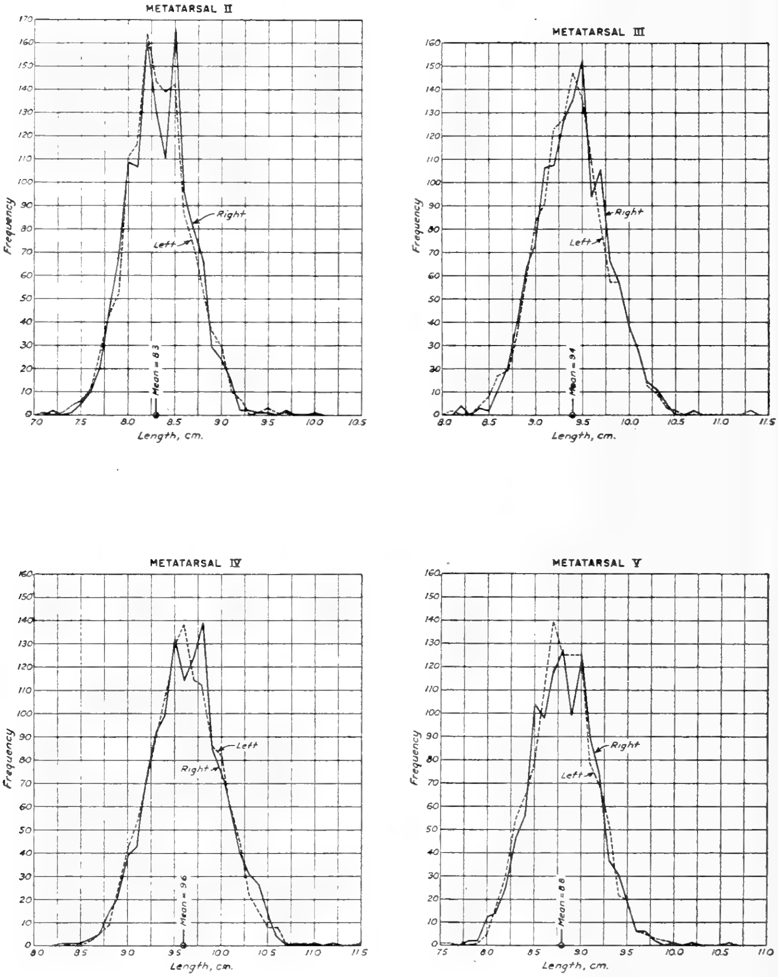


PLATE 8

Frequency distribution of lengths of metatarsals in *Canis* (*Aenocyon*) group

NEW OR LITTLE-KNOWN CRANE-FLIES FROM CALIFORNIA

(TIPULIDAE, DIPTERA), III

By CHARLES P. ALEXANDER

The preceding part under this general title was published in 1946 (Bull. So. California Acad. Sci., 45 1-16, pls. 1-2). At this time I am discussing some unusually interesting collections from Palomar Mountain, San Diego County, collected chiefly by Dr. John A. Comstock, with the able assistance of Mrs. Comstock, most of the specimens having been taken between July 1st and 7th, 1945. From July 11th to 13th, 1946, I was privileged to camp at this same place with Dr. Comstock and so personally investigate this most interesting station. Dr. Comstock observed that Tipulidae were much less common in 1946 than in the preceding year, when they came abundantly to his Coleman lanterns at the camp ground. At this place a small stream flows nearby but at the time of our visit in 1946 this was very low to intermittent and relatively few crane-flies were found here, either at light or by careful sweeping. The finest collecting was along the upper reaches of Doane Creek, along the Doane Valley trail, at an approximate altitude of 4700 feet. Here there is a beautiful permanent stream flowing down the mountain valley, providing ideal haunts for these flies. The forest cover was heavy and protected a rich under story of shrubs and herbs, the most evident being incense cedar, poison oak, box elder, brake, hellebore, nettle, red columbine, lupine, sweet cicely, yellow mimulus and many others. From such rank vegetation many of the flies were swept during the daytime while various others came to the Coleman lanterns operated at the head of the ravine on the evenings of July 11th and 12th. I cannot sufficiently thank Dr. Comstock for his appreciated interest in collecting these flies on Palomar Mountain and elsewhere in southern California. In accordance with the practice adopted in Part II of this series of papers the various species are numbered serially, those that had been reported in earlier papers under this title being given their original number, placed in parenthesis. Undoubtedly many further additions to the Palomar list will be made as a result of collecting at different places and at various seasons.

24. *Holorusia* (*Holorusia*) *grandis* (Bergroth) (*rubiginosa* Loew, nec *rubiginosa* Bigot).
Doane Valley Creek, July 6, 1945; July 12, 1946.

25. *Nephrotoma occidentalis* (Doane).
July 7, 1945.

(11) *Tipula* (*Trichotipula*) *beatula* Osten Sacken.
July 3-4, 1945; July 12, 1946.

26. *Tipula* (*Yamatotipula*) *meridiana* Doane.
July 12, 1946.

27. *Tipula* (*Oreomyza*) *comstockiana* sp. n.

Belongs to the *unca* (*borealis*) group; size large (wing over 16 mm.); general coloration of mesonotum light gray to buffy, the praescutum with darker stripes that are heavily and conspicuously bordered by brown, the anterior ends of the intermediate stripes much expanded; a short dorsopleural stripe; femora and tibiae obscure yellow, the tips narrowly infuscated; wings with a highly contrasted pattern of whitish subhyaline, medium brown and darker brown; *Rs* long, nearly three times *m-cu;* abdominal tergites trivittate with brown; male hypopygium with the outer dististyle short and broad; crest of inner dististyle with a brush of long fimbriate setae; lateral appendage with three processes, the median one a weak spinous lobe on the margin of the pendulous lower blade; eighth sternite trilobed, the lateral lobes distinctly longer than the median one, all provided with conspicuous yellow setae.

MALE: Length about 16-17 mm.; wing 17-17.5 mm.; antenna about 5.5-5.6 mm.

FEMALE: Length about 20-23 mm.; wing 18-22 mm.

Frontal prolongation of head buffy above, dark brown on sides; nasus usually long and slender; palpi dark brown. Antennae with scape whitened; pedicel obscure yellow; first flagellar segment brown, the remaining ones black; segments feebly incised. Head light gray, especially in front, with a capillary dark line on vertex.

Pronotum gray, restrictedly variegated with brown. Mesonotal praescutum light gray to buffy, heavily and conspicuously patterned with brown, the latter appearing as margins to the slightly darker gray stripes, the anterior ends of the intermediate dark pair much expanded and confluent with the margins of the lateral

stripes, isolating the posterior interspaces; posterior sclerites of notum gray, the scutal lobes slightly patterned with gray; mediotergite with an oval brown area on either side of the midline, the posterior border similarly darkened. Pleura and pleurotergite whitish gray, patterned with brown, including an incomplete dorsal stripe from the cervical region across the anepisternum, and the ventral sternopleurite, meron and katapleurotergite. Halteres light brown, base of stem yellow; knob infuscated. Legs with the coxae gray, in cases darkened basally; trochanters yellow; femora and tibiae obscure yellow, the tips narrowly infuscated; tarsi black, the proximal ends of the basitarsi yellow; claws (male) toothed. Wings with a highly contrasted pattern of whitish subhyaline, medium brown and darker brown, the amount of dark color slightly exceeding the pale, being much more extensive in the cubital and anal fields; cell *C* light brown, *Sc* yellow; stigma obscure yellow, especially the more costal portion; white band beyond cord completely traversing wing and involving almost all of cell R_5; further white areas in bases of cells M_1 and *2nd* M_2 and again basad of cord; cells R_1, *R* and *M* chiefly white; no postarcular darkening; veins brown, more yellowed in the pale fields. Venation: *Rs* long, nearly three times *m-cu*.

Abdominal tergites buffy, trivittate with brown, the posterior and lateral borders conspicuously of the ground color; sternites uniformly pale; hypopygium extensively pale brown. Ovipositor with cerci long and slender, nearly straight, much exceeding the hypovalvae. Male hypopygium having the spines of the ninth tergite, *9t,* slender. Outer dististyle, *od,* unusually broad, only about twice as long as wide, the apex obliquely obtuse. Inner dististyle, *id,* with the beak short but slender, slightly upcurved; lower beak stout; dorsal crest behind beak with a brush of long fimbriate or roughened setae; lateral appendage with three processes, including a flattened upper blade and a long pendulous lower one, the latter bearing a weak spinous lobe on outer margin before midlength. Gonapophysis, *g,* appearing as a narrow flattened sinuous blade, a little shorter than the aedeagus, not strongly bent at base, as in certain allied species. Eighth sternite, *8s,* distinctive; trilobed, the lateral lobes distinctly longer than the more truncated median one; all lobes densely provided with conspicuous yellow setae. Male hypopygium (Plate 9, Fig. 1).

Holotype, ♂, Palomar Mountain, altitude 4700 feet, July 5, 1945 (J. A. Comstock). *Allotopotype,* ♀, pinned with the type. *Paratopotypes,* 8 ♂ ♀, with the type; also July 12, 1946 (C. P. Alexander).

I take great pleasure in naming this striking fly for my good friend, Dr. John A. Comstock, distinguished authority on the West Coast Lepidoptera. The most similar Western Nearctic species is the more northern *Tipula* (*Oreomyza*) *alia* Doane,

which differs especially in the details of pattern of body and wings, in the shorter *Rs,* and in important details of structure of the male hypopygium, including the inner dististyle, lateral appendage and eighth sternite. The Wyoming record (Amer. Midl. Nat., 33; 406-407; 1945) of *alia,* based on a single female specimen may well pertain to the present fly but the male sex is necessary for exact determination.

28. *Tipula (Hesperotipula) micheneri* Alexander.
July 3-6, 1945; July 12, 1946.

29. *Tipula (Lunatipula) praecisa* Loew.
July 3, 1945; July 12, 1946. It seems probable that more than a single species is involved in this and other material from the general area.

30. *Tipula (Lunatipula) flavomarginata* Doane.
July 6, 1945.

31. *Tipula (Lunatipula) awanichi* sp. n.

Allied to *armata,* differing especially in the structure of the male hypopygium; basistyle not produced into a spine; outer basal lobe of inner dististyle a broadly flattened disk, at apex abruptly produced into a slender straight spine.

Male: Length about 17-18 mm.; wing 19-20 mm.; antenna about 5.5-6 mm.

Female: Length about 19-21 mm.; wing 18-19 mm.

Male with the frontal prolongation of head yellow; nasus elongate; palpi with basal segments brownish yellow, the outer segments passing into black. Antennae with basal three segments yellow, the succeeding ones weakly to strongly bicolored, yellow to obscure yellow, the small basal swellings darkened; outer segments more uniformly darkened. Head light gray with a narrow brown median stripe that is narrowed behind; setigerous punctures on posterior vertex blackened, conspicuous.

Pronotum brownish yellow. Mesonotal praescutum obscure yellow, with four reddish brown stripes, the intermediate pair separated by a yellow line that is about one-half as wide; posterior sclerites of notum gray, the scutal lobes with two confluent reddish brown areas. Pleura gray pruinose. Halteres with stem brownish yellow, knob brownish black basally, the apex pale. Legs with the coxae gray pruinose; trochanters yellow; femora yellow, the tips narrowly dark brown; tibiae obscure yellow; tarsi light brown, the outer segments darker; claws (male)

toothed. Wings with a weak brownish ground, rather conspicuously patterned with darker, including a small spot in cell *R* at near one-third the length, adjoining vein *R;* a larger area at origin of *Rs;* stigma; dark markings in centers of outer radial cells; prearcular and costal fields yellow; conspicuous whitened areas along the cord and beyond the stigma, the former reaching the posterior border along vein M_4; whitish streaks along outer end of vein *1st A* and at outer end of this cell closer to vein *2nd A;* veins brown. Venation: *Rs* about two and one-half times *m-cu; m* and petiole of cell M_1 subequal.

Abdomen yellow, the tergites with a narrow median stripe that is broken at the posterior borders of the segments and a much broken sublateral stripe, the latter restricted to spots on the basal rings; sternites yellow; hypopygium castaneous. Male hypopygium (Fig. 3) with the basistyle not produced into a spine, its outer end truncate; inner dististyle with both the beak and lower beak very obtuse and blackened at tips, in shape very similar to one another; outer basal lobe a broadly flattened disk, at apex abruptly produced into a slender straight spine. A single paratype (Yosemite) has the apex of the basistyle produced into a weak spine but otherwise agrees entirely with the present fly.

The female is darker throughout, including the mesonotal pattern. Ovipositor with both the cerci and hypovalvae elongate, the latter longer than the former.

Holotype, ♂, Palomar Mountain, altitude 4700 feet, July 4, 1945 (J. A. Comstock). *Allotopotype,* ♀, pinned with type. *Paratopotypes,* ♂ ♀, July 3-6, 1945, July 12, 1946; *paratypes,* 10 ♂ ♂, Mirror Lake, Yosemite, altitude 4000 feet, June 6, 1939 (Aitken & Downes); 1 ♀, Miami, Mariposa Co., June 7, 1940 (Cazier); 3 ♂ ♂, Wawona, Mariposa Co., altitude 5000 feet, June 6, 1939 (Downes); 1 ♂, Meadow Valley, Plumas Co., altitude 3500-4000 feet, June 15, 1924 (E. C. Van Dyke), California Academy of Sciences; ♂, Barton Flats, San Bernardino Mts., July 16, 1946 (J. L. Sperry).

The specific name, *awanichi,* is the Miwok name for the Yosemite Indians of the same stock. The present fly is close to *armata* Doane (*varia* Doane) and may prove to be a southern race of the same. In the latter fly the basistyle is produced caudad into a long spine; inner dististyle with its outer basal lobe obtuse or with only a slight indication of an apical point; lower beak of the inner style much smaller than the beak itself.

32. *Tipula* (*Lunatipula*) *vitabilis* sp. n.

Size medium (wing, male, 13 mm.); general coloration of mesonotum dull gray with three slightly darker stripes, the me-

dian one with slightly darker lateral borders; pleura and pleurotergite chiefly light yellow; wings with a weak brown tinge, the stigma darker; obliterative areas restricted; abdomen yellow, both the tergites and sternites with a median brown stripe; male hypopygium with the tergite and gonapophyses complicated by blackened spinous processes; basistyle with its outer end produced into a flattened black plate that is unequally bidentate at apex; eighth sternite with three groups of setae.

MALE: Length about 12.5 mm.; wing 13 mm.; antenna about 4.2 mm.

FEMALE: Length about 13-14 mm.; wing 14-15 mm.

Frontal prolongation of head yellow; nasus lacking; palpi with basal two segments brownish yellow, outer segments black, the terminal one elongate. Antennae (male) of moderate length, as shown by the measurements; basal three segments yellow, the apex of the third weakly darkened; remainder of flagellum uniformly black; flagellar segments only slightly incised, the basal swellings very small; verticils shorter than the segments; terminal segment an elongate thimble. Head above light gray, with a brown central stripe; vertical tubercle very low.

Pronotum buffy yellow, slightly darker above. Mesonotum with the ground dull gray, the three stripes very slightly darker gray, the median one delimited by more infuscated lateral margins; scutum and scutellum dark gray, the mediotergite light gray. Pleura and pleurotergite chiefly light yellow, the ventral sternopleurite gray. Halteres with stem obscure yellow, clear yellow at base; knob brownish black, the apex restrictedly yellow. Legs with the coxae and trochanters yellow: femora yellow, the tips narrowly infuscated; tibiae yellow, the tips evenly more narrowly darkened; tarsi passing into black; tarsal claws (male) toothed. Wings with a weak brownish tinge, the stigma darker brown; prearcular and costal fields, especially cell *Sc*, more yellowed; vague streaks or lines in certain of the cells; two small isolated obliterative areas, one before the stigma, the other across cell *1st* M_2; veins brown, more brownish yellow in the brightened fields. Venation: R_{1+2} entire; *m* oblique, about three-fifths as long as the basal section of M_3; petiole of cell M_1 longer than *m*.

Abdomen yellow, the tergites with a broad conspicuous central stripe, slightly interrupted at the posterior borders of the segments; no sublateral darkenings; sternites with a comparable but somewhat less distinct stripe; hypopygium brownish yellow. Male hypopygium with the ninth tergite and basistyle entirely cut off by sutures, the latter with its lower cephalic angle nearly square. Ninth tergite, *9t*, with a cephalic portion and a more caudal flat-

tened plate, the cephalic border of which is elevated into a transverse ridge, with the ends more elevated into spinous points that are directed dorsad; a smaller posterior pair of spines that are directed more caudad; beyond these spines, the outer part of the tergite is produced into a yellow plate on either side. (It is possible that this entire outer flattened structure, with the blackened armature, may fold backward onto the ventral surface of the tergite, as does the so-called *"tergal saucer"* in some species of the subgenus *Vestiplex*). Outer portion of ninth sternite, *9s,* ventrad of the basistyle, paler than the more basal portion. Appendage of sternite very low to scarcely developed, provided with several strong black setae; the small free ventral end with a few weaker yellow bristles. Basistyle, *b,* with the entire outer end produced caudad into a flattened black plate that is unequally bidentate at tip, the more dorsal spine longer and more acute. Outer dististyle, *od,* inserted near base of the major inner style, slightly expanded at base, narrowed outwardly. Inner dististyle, *id,* with the whole apical third a blackened head that is produced into a beak, the lower beak lacking; outer basal lobe lying unusually far distad, immediately back of the blackened head, appearing as a low lobe provided with long yellow setae. Gonapophyses, *g,* jutting from the genital chamber, appearing as paired blackened arms that are produced into an acute spine and an outer more elongate rod. Eighth sternite, *8s,* moderately sheathing, narrowed outwardly, the caudal margin with a triangular group of long yellow setae, subtended on either side by low lobes that are similarly provided with long yellow setae, the outermost a little shorter. Male hypopygium (Plate 9, Fig. 2).

Holotype, ♂, Palomar Mountain, altitude 4700 feet, July 4, 1945 (J. A. Comstock). *Allotype,* ♀, Del Mar, April 29, 1945 (J. A. Comstock). *Paratopotype,* 1 ♂, July 6, 1945; *paratypes,* 2 ♂ ♂, 1 ♀, with the allotype, April 1-29, 1945; 1 ♂, Hastings Reservation, Monterey County, along Finch Creek, June 21, 1943 (Jean Linsdale).

Although this fly shows some points of resemblance to species such as *Tipula* (*Lunatipula*) *mariposa* Alexander and *T.* (*L.*) *yosemite* Alexander, I believe it is closer to *T.* (*L.*) *atrisumma* Doane, a belief that is strengthened by the structure of the ovipositor. This structure is short and obtuse, somewhat as in *atrisumma;* cerci oval, with blunt tips, the entire surface covered with setae; hypovalvae very small, the tips produced into slender acute spines.

33. *Tipula* (*Lunatipula*) *bifalcata* Doane.
    July 3-7, 1945.

34. *Tipula* (*Lunatipula*) *megalabiata referta* subsp. n.

Characters as in the typical subspecies, *megalabiata* Alexander (Washington, Oregon, south to Yosemite, California; No. 7 of this series), differing in the details of structure of the male hypopygium, particularly the dististyles and the aedeagus.

As compared with *megalabiata*: Inner dististyles only slightly asymmetrical, both with a large foot-shaped lobe connecting the base of main body of style on outer face with the outer basal lobe. On one of the styles, the outer basal lobe is a trifle broader than on the style of the opposite side and bears a short marginal spine; otherwise the two styles appear quite similar in general outline, both provided with very long yellow setae. Aedeagus differently constructed; on either half with a single major spine occupying the outer edge, with two much smaller, more inner spines that are approximately equal to one another in size and shape.

Holotype, ♂, Palomar Mountain, altitude 4700 feet, along Doane Creek trail, July 12, 1946 (C. P. Alexander). The specimen was swept from shrubbery on the dry hillside, remote from water.

35. *Limonia* (*Limonia*) *sciophila* (Osten Sacken).
July 12, 1946.

36. *Limonia* (*Limonia*) *simulans concinna* (Williston).
July 6-7, 1945.

37. *Limonia* (*Dicranomyia*) *brevivena* (Osten Sacken).
July 4, 1945.

38. *Limonia* (*Dicranomyia*) *humidicola* (Osten Sacken).
July 7, 1945; July 11-12, 1946.

39. *Limonia* (*Dicranomyia*) *stigmata* (Doane).
July 3, 1945.

40. *Limonia* (*Geranomyia*) *canadensis* (Westwood).
July 6, 1945; July 12, 1946.

41. *Limonia* (*Geranomyia*) *diversa* (Osten Sacken).
July 3-6, 1945; July 12, 1946.

42. *Dicranoptycha laevis* Alexander.
July 12, 1946; type material.

(10) *Elliptera clausa* Osten Sacken.
July 3-7, 1945; July 12, 1946.

43. *Pedicia (Tricyphona) septentrionalis* (Bergroth), var.
July 4-6, 1945.

44. *Dicranota (Rhaphidolabis) cazieriana* Alexander.
July 4-6, 1945.

45. *Dicranota (Rhaphidolabis) neomexicana* (Alexander).
July 5, 1945.

46. *Austrolimnophila badia* (Doane).
July 6, 1945.

47. *Limnophila (Elaeophila) apiculata* Alexander.
July 7, 1945; 1 female.

48. *Limnophila (Elaeophila) edentata* Alexander.
July 4-7, 1945; July 12, 1946.

49. *Limnophila occidens* Alexander.
July 7, 1945.

50. *Hexatoma (Eriocera) palomarensis* sp. n.

Allied to *californica;* general coloration of thorax light brown or reddish brown, the praescutum with four darker brown stripes, the intermediate pair narrow; vestiture of body short and sparse; antennae (male) elongate, approximately twice the length of wing; femora obscure brownish yellow, the tips narrowly brownish black, the amount subequal on all legs; wings with a strong light brown ground, vaguely patterned with slightly darker brown and more yellow areas, the former including the stigma; sparse macrotrichia on outer radial and medial veins.

MALE: Length about 14-15 mm.; wing 16-17 mm.; antenna about 34-35 mm.

FEMALE: Length about 23 mm.; wing 18 mm.

Rostrum obscure yellow; palpi with the first segment obscure yellow, the remainder black, provided with conspicuous black setae. Antennae (male) elongate, as shown by the measurements; scape, pedicel and base of first flagellar segment obscure yellow, the remainder of the organ black; flagellar segments provided with elongate spinous setae that become longer, more delicate and more widely spaced on the outer segments; proportions of flagellar segments, 1-4.4 mm.; 2-6.1 mm.; 3-10.5 mm. In average *californica,* flagellar segment 1-6.5 mm.; 2-9 mm.; 3-14 mm.;

total length 40 mm. Head light reddish brown, golden yellow pollinose.

Pronotum brownish yellow. Mesonotal praescutum with the disk reddish brown, the lateral borders gray; four darker brown stripes, the intermediate pair narrow, representing the borders of a much paler central stripe, the darkened portions only about one-third as wide as the pale central line; lateral stripes broader; posterior sclerites of notum reddish brown, the centers of the scutal lobes and the scutellum slightly darker, the mediotergite vaguely pruinose. Pleura and cephalic portion of pleurotergite more heavily pruinose; dorsal portion of pleura, before the wing-root, restrictedly more darkened. Vestiture of body, especially the head, mesonotum and abdomen very short and sparse, as compared with *californica*. Halteres short, stem yellow, knob conspicuously blackened. Legs with the coxae heavily light gray pruinose; trochanters obscure yellow; femora obscure brownish yellow, clearer yellow at bases, the tips narrowly brownish black, the amount subequal on all legs; tibiae and tarsi brownish yellow, the terminal segment more blackened. Wings (Fig. 4) with a strong light brown ground, vaguely patterned with slightly darker brown and more yellowish areas; the darker portions include the proximal part of the costal field and the poorly indicated stigma; the paler areas occur as central streaks in cells R, R_1, M and *1st* A; veins beyond cord dark brown, basad of cord becoming yellow. Macrotrichia on outer radial veins, in the medial field restricted to three or four trichia on veins M_1 and M_2, the trichia more abundant than in *californica*. Venation: R_{2+3+4} variable, from a little shorter to slightly longer than the basal section of R_5; cell M_1 subequal to its petiole.

Abdominal tergites obscure brownish yellow, vaguely more darkened medially but not forming a stripe; sternites and hypopygium more uniformly yellow.

Holotype, ♂, Palomar Mountain, altitude 4700 feet, along stream, July 6, 1945 (J. A. Comstock). *Allotype*, ♀, near Seven Oaks, San Bernardino Mts., altitude 5800 feet, August 10, 1946 (J. L. Sperry). *Paratopotype*, ♂, along dry trail above stream, July 12, 1946 (J. A. Comstock); *paratypes*, 1 ♂, pinned with allotype; a few ♂♂, Barton Flats, San Bernardino Mts., altitude 6300 feet, swarming beneath incense cedar trees at camp, July 15, 1946 (C. P. Alexander).

This interesting fly is most nearly allied to *Hexatoma* (*Eriocera*) *californica* (Osten Sacken), of the costal redwood belt of central California. The latter differs in the somewhat larger size, details of coloration, conspicuously hairy body, and markedly different proportions of the antennal segments.

51. *Hexatomia (Eriocera) saturata* (Alexander).

July 12, 1946; 1 badly eaten body, with a single wing, found in a spider's web, altitude 4700 feet.

52. *Gnophomyia (Gnophomyia) comstocki* sp. n.

General coloration of mesonotum brownish gray, the thoracic pleura dark brown dorsally, reddish brown beneath, with a pale yellow longitudinal stripe; wings grayish yellow, stigma very pale brown; branches of *Rs* elongate, all extending generally parallel to one another; *m-cu* about one-fifth to one-sixth its length beyond the fork of *M;* male hypopygium with a large brush of blackened setae on mesal face of basistyle; outer dististyle a long curved blackened rod, at apex with a long row or brush of very long crinkly yellow setae; inner dististyle bent very strongly at near midlength, the apex obtuse.

MALE: Length about 6.5 mm.; wing 5.8 mm.; antenna about 1.2 mm.

Rostrum brown; palpi black. Antennae with scape and pedicel black, flagellum dark brown; flagellar segments elongate-oval to subcylindrical; longest verticils only slightly exceeding the segments. Head dark gray.

Pronotum above light yellow, dark brown on sides; pretergites clear light yellow. Mesonotal praescutum and scutum dark brownish gray, the former with an intermediate pair of more brownish stripes; humeral and lateral regions of praescutum yellow; pseudosutural foveae brownish black; scutellum obscure brownish yellow; mediotergite dark brown, the lateral portions, with the pleurotergite, more reddish brown. Pleura variegated brown and pale, the latter including a broad ventral stripe extending from behind the fore coxae to the base of abdomen; ventral pleurites reddish brown, the dorsal ones much darker, producing a short dorsal stripe from the cervical region to the pteropleurite. Halteres yellow, knob very insensibly darker. Legs with the coxae and trochanters yellow; femora obscure yellow, the tips more infuscated, broadest on the fore legs, very narrow on the posterior pair; tibiae and basitarsi obscure brownish yellow, the tips more infuscated; remainder of tarsi black. Wings (Fig. 5) with a grayish yellow tinge, the prearcular and costal fields clearer yellow; stigma very pale brown, poorly defined; veins pale brown, more yellowed in the brightened fields. Venation: Sc_1 ending nearly opposite the fork of *Rs*, Sc_2 far from its tip; R_2 about twice as long as R_{2+3} or one-half R_{2+3+4}; R_{1+2} elongate, all extending generally parallel to one another; cell *1st* M_2 nar-

row, about equal in length to vein M_4; *m-cu* about one-fifth to one-sixth its length beyond the fork of *M*.

Abdomen light brown, the hypopygium more brownish yellow. Male hypopygium (Fig. 6) with the basistyle, *b*, relatively stout, on mesal face at near midlength with a large group or brush of abundant blackened setae, directed caudad; apex of basistyle a trifle produced beyond the bases of the dististyles. Outer dististyle, *d*, a long curved black rod, the tip with three or four pale teeth; immediately before apex of style with a long row or brush of very long crinkly yellow setae; mesal face of style near base with a series of blackened teeth or knobs. Inner dististyle shorter, very strongly bent at near midlength, the apex obtuse. Phallosomic plate, *p*, broad, the central portion a little elevated, at the summit restrictedly blackened. Aedeagus relatively slender, gently sinuous, the tip produced into a long spinous point.

Holotype, ♂, Palomar Mountain, altitude 4700 feet, July 4, 1945 (J. A. Comstock). *Paratopotypes*, 4 ♂♂, July 4-7, 1945; July 12, 1946 (Comstock & Alexander).

This entirely distinct fly is named for Dr. Comstock, in appreciation of his many kindnesses to me in our study of the Tipulidae of California. The species is entirely different from all others so far discovered in the New World. The very peculiar male hypopygium renders comparison with any other regional form quite unnecessary.

53. *Gonomyia (Idiocera) californica* Alexander.
July 6-7, 1945.

54. *Gonomyia (Idiocera) coloradica* Alexander.
July 3-7, 1945, July 12, 1946.

55. *Gonomyia (Idiocera) proserpina* Alexander.
July 12, 1946. This distinct fly, hitherto recorded only from the Rocky Mountain states, was common at Barton Flats, in the San Bernardino Mountains, later in July 1946.

56. *Gonomyia (Gonomyia) poliocephala* Alexander.
July 4, 1945.

57. *Gonomyia (Gonomyia) aciculifera* Alexander.
July 12, 1946. This specimen differs slightly from other California materials, particularly in wing pattern and venation, but I regard the identification as correct.

58. *Gonomyia (Gonomyia) flavibasis* Alexander (*tuberculata*) Alexander.
July 12, 1946.

59. *Rhabdomastix (Sacandaga) californiensis* Alexander. *lata* Alexander).
July 3, 1945; July 12, 1946.

60. *Erioptera (Psiloconopa) bipartita* Osten Sacken.
July 12, 1946.

61. *Erioptera (Mesocyphona) eiseni* Alexander.
July 12, 1946.

62. *Erioptera (Symplecta) cana* (Walker).
July 4, 1945.

63. *Molophilus (Molophilus) palomaricus* sp. n.

Belongs to the *plagiatus* group; general coloration brownish black to black, the surface subopaque; antennae (male) elongate, about one-half the length of wing; flagellar segments elongate-subcylindrical, the longest verticils unilaterally distributed, one on each segment; knobs of halteres light yellow; legs brownish black, the femoral bases restrictedly obscure yellow; wings with a dusky tinge, the stigmal region slightly darker but diffuse; male hypopygium with the basal dististyle a long curved black rod, very gradually narrowed to the acute apex; phallosomic plate narrow, the apex obtuse, surface glabrous.

MALE: Length about 3.5 mm.; wing 3.8 mm.; antennae about 1.9-2.0 mm.

Rostrum and palpi black. Antennae (male) elongate, black throughout; flagellar segments elongate-subcylindrical to truncate-fusiform, with vestiture of four distinct sizes, the longest being single unilaterally distributed verticils, one near base of each segment; the next longest include pale erect setae of approximately two-thirds the length. Head blackish, the anterior vertex slightly more pruinose.

Thorax brownish black, the surface subopaque. Halteres with stem dusky, the base narrowly yellow, knob conspicuously light yellow. Legs with the coxae and trochanters yellow; remainder of legs brownish black, the femoral bases restrictedly obscure yellow, somewhat more extensively so on the posterior legs. Wings with a dusky tinge, the stigmal region slightly darker but diffuse; veins brown. Venation: R_2 some distance beyond level of *r-m*,

R_{2+3} being nearly three times as long as R_{4+5}; petiole of cell M_3 a little more than twice *m-cu;* vein *2nd A* sinuous, ending about opposite the caudal end of *m-cu.*

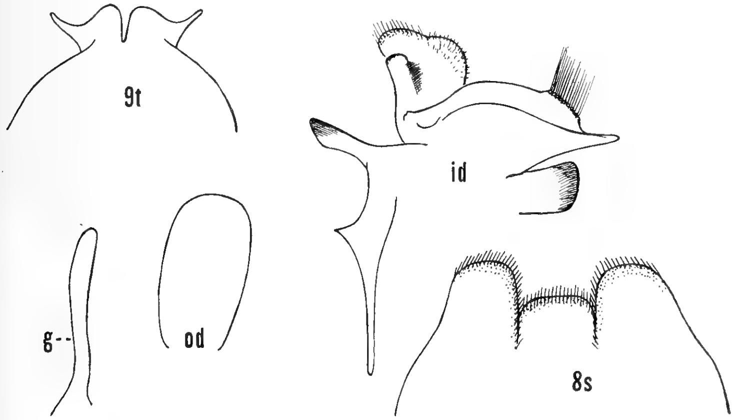
Abdomen, including hypopygium, black. Male hypopygium (Fig. 7) with the beak of ventral lobe of basistyle, *b,* slender, straight. Outer dististyle with both arms slender, the longer one even more narrowed. Basal dististyle, *bd*, a long curved black rod from a dilated base, very gradually narrowed to the acute apex; surface with scattered microscopic punctures over most of the length. Phallosomic plate, *p,* narrow, the apex obtuse, surface glabrous.

Holotype, ♂, Palomar Mountain, altitude 4700 feet, July 6, 1945 (J. A. Comstock). *Paratype,* ♂, Sequoia National Park, entrance, route 198, altitude 4000 feet, July 18, 1946 (C. P. Alexander).

Molophilus (*Molophilus*) *palomaricus* is very distinct from the two other described species in the southwestern United States belonging to the same group (*arizonicus* Alexander, *ursus* Alexander). It differs decisively in the structure of the male hypopygium, particularly the basal dististyle. In this latter regard it somewhat suggests various Mexican species, such as *M.* (*M.*) *falx* Alexander, *M.* (*M.*) *sagax* Alexander, and *M.* (*M.*) *severus* Alexander, differing from all in the structure of the male hypopygium and antennae. As regards the antennae, it is most similar to *sagax.*

64. *Molophilus* (*Molophilus*) *perflaveolus* Alexander.
July 12, 1946.

65. *Molophilus* (*Molophilus*) *spiculatus* Alexander.
July 4, 1945.



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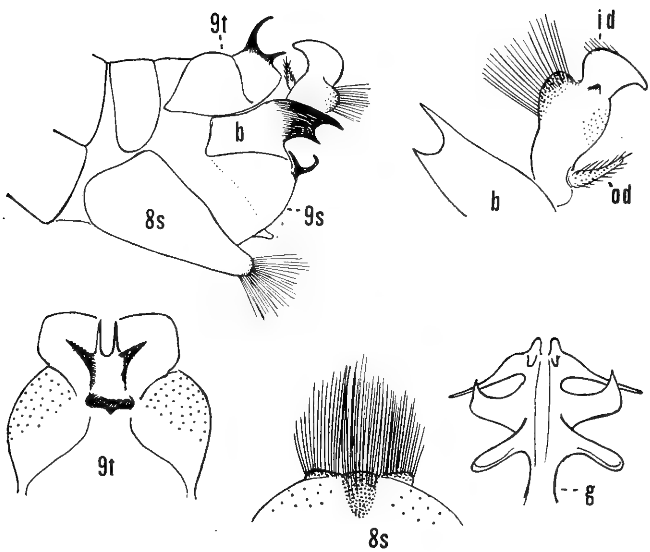

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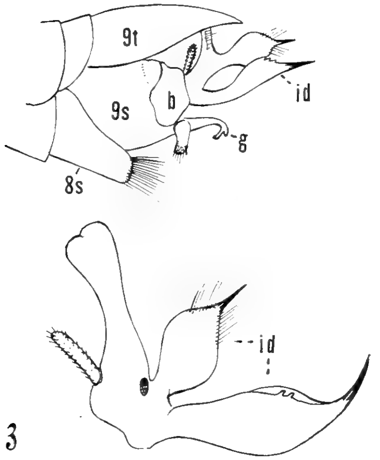
PLATE 9

Details of male hypopygia

FIG. 1. *Tipula* (*Oreomyza*) *comstockiana* sp. n.

FIG. 2. *Tipula* (*Lunatipula*) *vitabilis* sp. n.

(Symbols: *b*, basistyle; *g*, gonapophysis; *id*, inner dististyle; *od*, outer dististyle; *s*, sternite; *t*, tergite).



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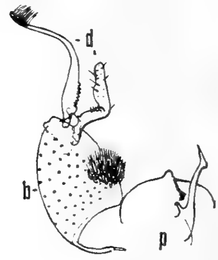

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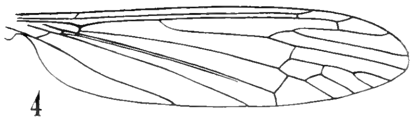

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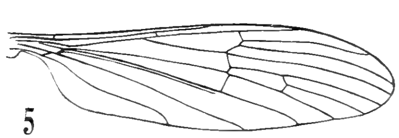

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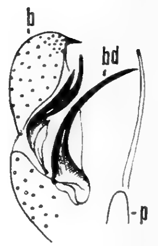

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PLATE 10

FIG. 3. *Tipula (Lunatipula) awanichi* sp. n.; male hypopygium.
FIG. 4. *Hexatoma (Eriocera) palomarensis* sp. n.; venation.
FIG. 5. *Gnophomyia (Gnophomyia) comstocki* sp. n.; venation.
FIG. 6. *Gnophomyia (Gnophomyia) comstocki* sp. n.; male hypopygium.
FIG. 7. *Molophilus (Molophilus) palomaricus* sp. n.; male hypopygium.

(Symbols: *b*, basistyle; *bd*, basal dististyle; *d*, dististyles; *g*, gonapophysis; *id*, inner dististyle; *p*, phallosome; *s*, sternite; *t*, tergite).

THE FAUNA AND FLORA OF THE EL SEGUNDO SAND DUNES

16. A NEW EUCOSMA FROM THE EL SEGUNDO SAND DUNES

(Olethreutidae: Lepidoptera)

By J. F. GATES CLARKE

Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, United States Department of Agriculture

The following new species was submitted by Dr. John A. Comstock and is being described as a contribution to a series of papers by Dr. Comstock and his associates on the ecology of the El Segundo Sand Dunes of California.

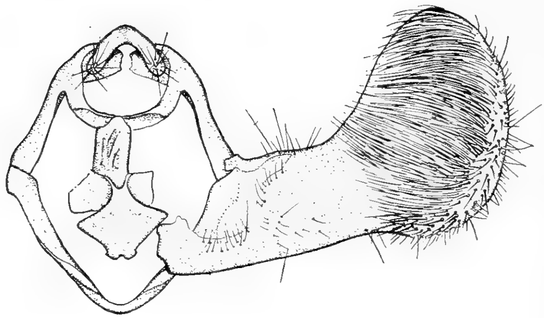
Dr. Comstock has generously consented to my naming this *Eucosma* and will add notes on the metamorphosis of the species at the end of the description.

The drawings of the genitalia were made by the author.

EUCOSMA HENNEI, new species

Labial palpus pale luteous to brown with sparse fuscous scaling exteriorly. Antenna fuscous with pale annulations. Head and thorax pale luteous to dark brown, with considerable fuscous shading posteriorly. Ground color of forewing pale yellowish fuscous overlaid and irrorated with varying amounts of fuscous scaling; basal patch ill-defined or absent but when present dark gray; from costa, at basal third a transverse, dark gray fascia extends almost to fold, turns outwardly to near middle, then continues transversely, and more broadly, to dorsum; in some specimens this fascia is represented only by a dark blotch on dorsum; from costa, an outwardly curved, crescentric dark gray, narrow fascia extends to tornus; this line is obsolete in some specimens; both fascia, though generally clearly visible, are not sharply contrasted to the remainder of the wing because of the large amount of dark scaling on the entire surface; the lighter areas of the wing are covered with fine brown reticulations and a distinct brown line borders the apex and termen; in the apical third of wing are dull leaden scales between the brown reticulations; cilia yellowish fuscous with a gray subbasal band. Hind wing pale yellowish fuscous basally shading to light fuscous around margins; cilia pale yellowish fuscous with a darker subbasal band. Fore- and midlegs brown; hind legs ocherous white shading to brown on the tarsi. Abdomen ocherous white tinged with fuscous beneath.

Male genitalia.—Harpe of about equal width to cucullus, the latter about twice as wide as neck of harpe and evenly rounded. Aedeagus short and stout; vesica armed with four or five cornuti.



Eucosma hennei, male genitalia

Eucosma hennei, female genitalia

PLATE 11

Female genitalia.—Genital plate membranous with a rectangular sclerotized area posterior to the round ostium. Ductus bursae membraneous; inception of ductus seminalis at middle, dorsally, of ductus bursae. Signa two.

Alar expanse 17-30 mm.

Type.—United States National Museum No. 58210.

Type locality.—El Segundo Sand Dunes, Los Angeles County, California.

Food plant.—*Phacelia ramosissima subsinuata* Mcbr.

Remarks.—Described from the male type, eight male and nine female paratypes, all from the same locality. The moths were reared from larvae collected by Mr. C. Henne, feeding in the roots of the food plant. The moths emerged from September 13 to October 13, 1940.

This stunning species is the more remarkable because of its great variation in size. Although considerable variation may be expected in borers, few show as much difference in sizes of individuals as does this species.

Because of the great variation between individuals, caution should be used by anyone comparing the description with specimens. The genitalia, however, should suffice to distinguish this species from all other described forms.

E. hennei is nearest to *E. dorsisignatana* (Clem.) but can be distinguished from that species by the absence of the sharply contrasted dark dorsal marking.

I take pleasure in naming this species for Mr. Henne, who has contributed greatly to the knowledge of western Lepidoptera.

17. NOTES ON THE EARLY STAGES OF EUCOSMA HENNEI Clarke

By JOHN ADAMS COMSTOCK

During the course of an ecological survey of the El Segundo Sand Dunes conducted by Dr. W. Dwight Pierce, a number of wood-boring lepidopterous larvae were collected by Dr. Pierce and others from the woody stems and upper portion of the roots of *Phacelia tanacetifolia* Benth. The first examples were taken August 31, 1938. Subsequently, in 1940, Chris Henne secured a quantity of the larvae which were reared to maturity.

Brief notes were made of the larva and pupa by the writer, as follows:

Mature Larva: Varies greatly in length depending on the girth and condition of the stems in which they occur.

Body color, light straw. Robust, and grub-like in appearance.

Legs, light straw colored, the terminal segment tipped with brown. Prolegs concolorous with body. Crotchets, brown. Spiracles, rimmed narrowly with brown, the centers concolorous with body.

A straw-colored glistening scutellum occurs on the first segment.

Head, orange brown, with orange mottling over the center of each cheek. Mandibles, dark brown.

Pupation occurs immediately within the exit of the burrow, and the pupa is partly extruded at the time of hatching.

Pupa: Length of average specimen 12 mm. Subfusiform, the cephalic end well rounded and the cauda blunt and free of cremasteric hooks.

The surface is relatively smooth throughout except for a series of spicules arranged in transverse rows. Each typical intersegmental juncture is margined anteriorly and posteriorly with one of these rows, all of which, however, occur only on the dorsum, and fade out laterally as they approach the spiracles.

The spicules aforementioned incline somewhat caudally, and undoubtedly assist the pupa in moving forward in the burrow.

Eyes, prominent and rounded. Antennae extending approximately ⅔ the distance towards margin of wings. The ends of the metathoracic legs are in line with the wing margins.

Color of pupa, uniform light brown. The eyes become markedly darker as the time of emergence approaches.

Larvae collected in August emerged in September and October of the same year.

Plate 12 illustrates the pupa.

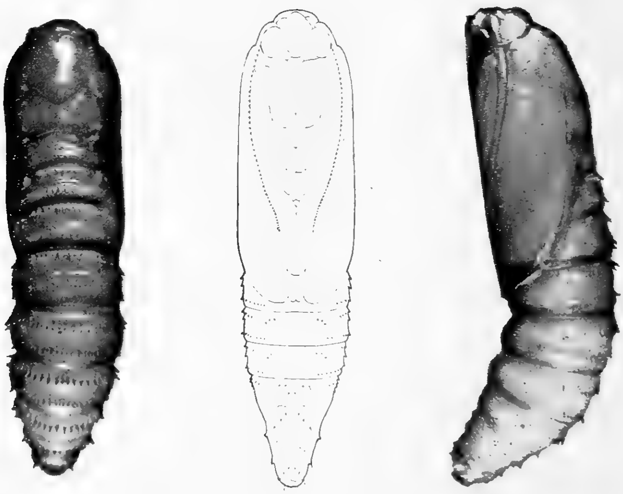


PLATE 12

Pupa of *Eucosma hennei*, enlarged X 5

EGG LAYING OF THE EUROPEAN BROWN SNAIL IN TERRARIA

By WILLIAM MARCUS INGRAM
Mills College, California

Data included here deal with the egg laying activity of the European Brown Snail, *Helix aspersa* Müller, in terraria during January and February of 1942, thus adding information pertinent to the natural history of this species in California.

The snails under observation were collected on the Mills College Campus, Oakland and were placed in terraria in pairs. The bottoms of the terraria were covered with moist clay soil and the tops with glass plates with air holes. The snails were fed on lettuce. Individuals were observed through just one egg laying. The room in which the snails were kept was shielded from direct sunlight throughout the day. During the observations the mean temperature of the room was 67 degrees Farenheit with a low temperature of 61 degrees and a high temperature of 73 degrees; the mean humidity was 66 with a low humidity of 56 and a high of 75.

In depositing eggs the snails never laid them on the surface of the soil, but dug a cavity in the substratum which varied in depth from one-half to one and one-half inches.

The greatest number of eggs deposited in a nest was ninety-nine and the least was thirty. (Table 1). The mean number of eggs laid by sixteen snails was fifty-eight. This number is much less than the mean number observed from twenty snails in the field in southern California by Basinger (1931); this investigator recorded a mean number of 86.6 eggs, with a maximum of 119 and with 33 as a minimum. Basinger (1931) found eggs in March, April, June, August, and September. His nests were discovered principally in orange groves. The terraria snails as mentioned above laid in January and February. In the field in Oakland snails were observed laying in September, October, November, January, and February.

The percentage of eggs laid that hatched in terraria was only recorded in nine instances, and varied from a high of seventy-three per cent to zero per cent with a mean, including the total failure of one clutch to hatch, of forty-five and seven-ninths per cent. The incomplete data indicate that the percentage of eggs hatching under the stated conditions seem to be relatively low for an animal whose eggs are so well concealed. No visual differ-

ence between terraria could account for the variation in the percentage of the number of eggs hatching.

Basinger's (1931) data indicate that on a basis of five incubation periods that the eggs of *Helix aspersa* hatch in sixteen and three-fifths days; he also states, "During ordinary summer weather, the eggs hatch in about two weeks, but this time may be shortened somewhat during the warmer part of the summer or lengthened during the cooler seasons." The writer's terraria data show a mean hatching time of fifteen days with a high incubation interval of twenty-one days and a low of ten days.

Young snails on hatching remained under the soil from a minimum of one to a maximum of seven days before working their way to the surface of the soil; on emerging from the soil they immediately began feeding on lettuce. The mean time it took for fifteen lots of snails from separate nests to reach the surface of the soil was four and one-half days.

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Table 1—EGG LAYING OF HELIX ASPERSA MÜLLER IN TERRARIA

Oviposition	Number of Eggs	Hatching Time	Percentage of Eggs Hatching
January 10	35	none hatched	none hatched
January 20	53	18 days	22 per cent
January 26	96	21 days	no record
January 28	65	13 days	no record
January 3	30	11 days	73 per cent
January 25	40	10 days	42 per cent
January 25	57	16 days	05 per cent
January 30	56	17 days	73 per cent
January 30	67	12 days	70 per cent
February 9	81	no record	no record
February 4	99	15 days	67 per cent
February 1	60	no record	60 per cent
February 16	67	14 days	no record
February 28	65	no record	no record
February 6	53	17 days	no record
February 9	37	19 days	no record

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ASYMMETRICAL VALLEYS OF SAN DIEGO COUNTY, CALIFORNIA

By K. O. EMERY
University of Southern California

INTRODUCTION

One of the most prominent physiographic features of San Diego County is a marine wave-cut terrace which extends from north of Oceanside to south of the Mexican border (Hanna, 1926). It reaches a width of 12 miles and ranges in elevation from about 350 feet above sea-level near the ocean to 450 feet or more farthest inland, where it is limited by a high area of resistant igneous and metamorphic rocks. This is known as the San Diego Terrace. Two large valleys have divided the terrace into three main sections, two of which are sometimes referred to as the Linda Vista Terrace and the Otay Terrace, although all are included by the term San Diego Terrace (Hertlein and Grant, 1944). Other much less extensive terraces are present at higher and lower elevations.

The San Diego Terrace was cut in late Pliocene or early Pleistocene times across Eocene and Pliocene poorly consolidated shales, sandstones, and conglomerates. These strata dip regionally southward and southeastward, but only a few degrees. In parts of the area, dips are steeper and locally the rocks even dip northeastward. The bevelled edges of the Eocene and Pliocene rocks are capped by a layer of terrace conglomerate called the Sweitzer formation, which reaches a thickness of 20 feet or more and is relatively resistant to erosion. Over part of its original area the terrace is flat and uneroded, but its northern and southern thirds have been so thoroughly dissected that only isolated portions of the original surface remain between some of the valleys.

Many of the stream valleys which have been cut into the San Diego Terrace are characterized by a peculiar asymmetrical cross-section. In general, the valley wall on the south side of a stream (north-facing wall) is steeper than the wall on the north side (south-facing wall), Plate 13, fig. A. This type of cross-section is most pronounced for valleys draining westward with a moderate gradient.

Numerous valleys were examined on the ground and from the air. A few slope measurements were made but it became obvious that a prohibitive amount of time would be required to complete all the slope measurements needed for a study of the cause of asymmetry. A fairly satisfactory substitute was found through use of the San Diego, La Jolla, and Oceanside Quadrangles published by the U. S. Geological Survey. Each has a 25 foot contour interval. Cross-sections were drawn at half-mile intervals across all valleys cut more than 100 feet below the terrace surface. The shortest horizontal distance between valley wall contours having a 100 foot difference in elevation was measured, and then the slope in degrees was computed. Measurements were also made of the valley gradient and the azimuth of the downstream direction relative to true north. The results of this rather rough method agree reasonably well with the field observations. Perhaps in the future, some students of physiography may be able to devote more time to the field approach, not only in the San Diego region, but also in other areas where asymmetrical valleys exist.

Relation of Symmetry to Other Factors

Symmetry Index.—The most satisfactory method of indicating symmetry was found to be the ratio of the slope of the left wall in degrees to the slope of the right wall in degrees, where left and right walls are relative to an observer facing downstream. If the valley were perfectly symmetrical, the quotient would be 1.0; if the left wall were steeper, the quotient would be greater than 1.0; and if the right wall were steeper, the quotient would be less than 1.0. This quotient, introduced here as the *symmetry index,* was found to vary between 0.25 and 5.0.

Azimuth.—The azimuth expresses the direction relative to true north followed by the stream drainage. Plate 14 shows the relationship between symmetry index and azimuth for cross-sections of valleys having gradients between 0°10′ and 1°00′. Although the points are badly scattered, the median curve indicates that the valleys are most asymmetrical when draining westerly (between azimuths of 245° and 295°). For these valleys the median left (or north-facing) wall is nearly twice as steep as the right (or south-facing) wall. On the other hand, valleys having azimuths between 155° and 185° have median symmetry indices of about 0.8; in other words, the left (or west-facing) wall is only about eight-tenths as steep as the right wall. Thus the left wall is steeper for valleys draining westward, while the right wall is steeper for valleys trending east of south. The median curve indicates that valleys having an azimuth of about 200° should be symmetrical, with left and right walls equally steep, but there are only a few points in this part of the graph. There are also but few data for valleys

having northward drainage, but the available data do suggest a similar relationship, with the symmetry index decreasing northward to about 360°, where the left (or east-facing) wall is less steep than the right (or west-facing) wall.

Gradient.—Part of the spread of points in Plate 14 results from variation in gradient of valleys. To determine the importance of this factor the symmetry indices of all valleys having azimuths between 245° and 295° were plotted against their gradients, Plate 15. Note that while Plate *2* includes only moderate gradients, Plate 15 is based on all gradients. Plate 15 indicates that the greatest asymmetry (with left or north-facing wall steeper than right or south-facing wall) exists for valleys having gradients of about 0°20′. The asymmetry gradually decreases for steeper gradients up to about 1°30′. For valleys having even steeper gradients, the median symmetry index approaches 1.0 and the valleys are nearly symmetrical, Plate 13, fig. B. Valleys having gradients gentler than about 0°10′ show a large spread of symmetry indices but the median value is lower than for moderate gradients, or, in other words, valleys of very gentle gradient have nearly equally steep walls. Some of the spread of points in Plate 15 is due to varying azimuth but most of the spread doubtlessly is the result of inadequacy of the map contours for estimating the exact degree of slope.

Stage of Valley Evolution.—Most of the valleys with very gentle gradients and nearly equally steep walls (Plate 15) are mature with the streams meandering over aggraded floodplains. The valleys of moderate gradient, characterized by greatest asymmetry, are youthful, with the stream bed occupying nearly the entire valley bottom. The valleys of very steep gradient, with relatively symmetrical wall slopes, are of extreme youthful age and partly result from very rapid down-cutting where the mouth has been lowered by marine erosion (Plate 13, fig. B).

CAUSE OF ASYMMETRY

The number and variety of causes of asymmetry of valleys in other regions suggested during the past are truly remarkable. Causes given in the literature are as follows: earth rotation, wind driven waves, wind driven rain, recent regional tilt, lateral down-dip shift of stream axis, protection by snow and ice, and protection by vegetation.

The most popular of these suggestions is the effect of earth rotation in causing differential lateral erosion. Papers applying this theory have been written by Baer (1860), Kerr (1873), Lewis (1877), Gilbert (1884), Baines (1884), Jefferson (1904), Taylor (1906), Davis (1908), Brunhes (1910), Eakin (1910), Fuller

(1914), and Glock (1932). These authors have described asymmetry of valleys in France, Australia, Siberia, Michigan, Colorado, Long Island, and of the Mississippi, the Missouri, and the Yukon Rivers. Penck (1894) and Fabre (1903) summarized most of the early European literature on the subject. Theoretically, in the northern hemisphere earth rotation deflects streams to the right, thereby tending to produce steeper right walls than left walls of valleys, regardless of the direction of flow, or azimuth. Asymmetry due to this cause should, accordingly, be characterized by a symmetry index less than 1.0 in all azimuths. Plates 14 and 15 show that most of the valleys measured have symmetry indices greater than 1.0 except in certain azimuths, thereby eliminating earth rotation as an effective agent controlling valley symmetry in the area studied.

Fairchild (1932) believed the effect of earth rotation to be of too small magnitude even in the "type region" on the south side of Long Island but proposed instead that the prevailing easterly and southerly winds in that area caused preferred erosion of the west, or right bank of the streams, thereby giving rise to asymmetrical cross-sections. Bowman (1904) from detailed studies of charts of the Mississippi River concluded that wind was at least as important as earth rotation in deflecting streams. Jennings (1922) considered wind important at Long Island because it caused sand to be deposited in the lee of the windward bank, forcing the streams westward, to the right. In the San Diego area, the winds are not very strong and are variable, but mostly from the west or northwest. If winds were the cause of asymmetry here, the symmetry index then should be highest for streams draining southward or southwestward and lowest for opposite azimuths. This is not true as shown by Plate 14, and the wind effect therefore cannot be important. A different effect of wind was proposed by Fabre (1903). He explained that rain driven by the wind falls diagonally through the air and that if a valley trends at right angles to the wind direction its side walls must receive greatly different amounts of rainfall. Since more rain falls on the down-wind side, erosion is faster there and the slope accordingly is made gentler than the up-wind side. In the San Diego area this process would develop the lowest asymmetry indices for southward draining valleys and the highest indices for northward draining ones, a condition also different from the observed facts.

Some Michigan rivers were found by Jefferson (1907) to prefer the southwest side of their flood-plains, with resulting probable development of asymmetry of walls. He suggested that this might have been caused by recent regional tilt to the southwest. In the area studied, the San Diego River is the only stream having an appreciable floodplain and it seems to have no favored side. Moreover, if tilting had taken place recently it should have been a south-

PLATE 13

FIG. A. View eastward up San Clemente Canyon from Soledad Mountain. Note that south wall is much steeper than north wall and that vegetation is much denser on it.

FIG. B. View westward down small canyon north of Scripps Institution of Oceanography. Note that the north and south walls of this steep gradient canyon have about equal slopes but that vegetation is much denser on the south wall.

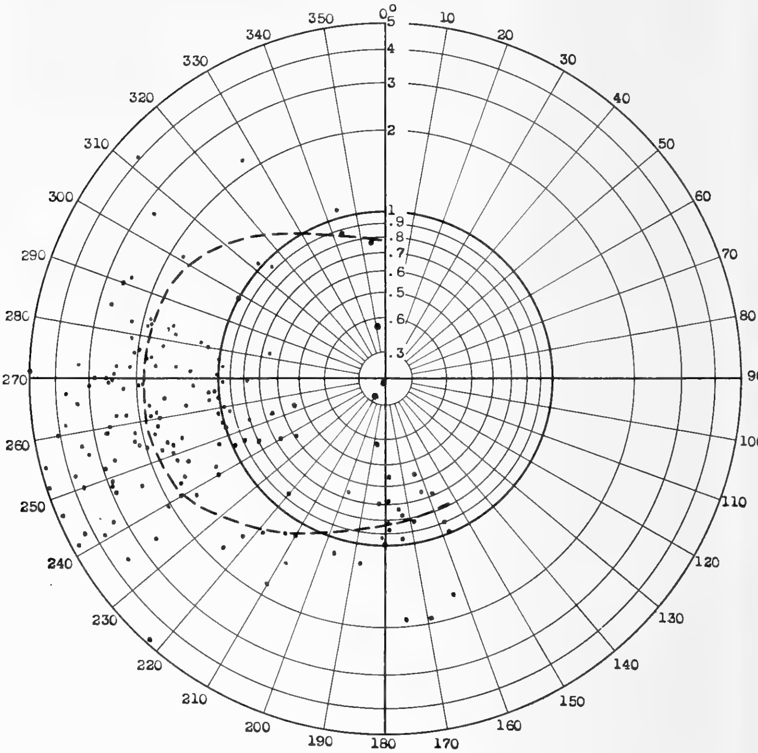


PLATE 14

Symmetry index (slope of left wall divided by slope of right wall) plotted against azimuth (direction of valley axis). Note that left wall of valleys draining westerly is steeper, in contrast to valleys draining southerly or northerly where right wall is slightly steeper. Only valleys having gradients between 0°10′ and 1°00′ are plotted.

ward tilt to account for the observed symmetry indices. Such a tilt would have affected the marine terraces into which the valleys are cut, but these are nearly horizontal.

A major cause of asymmetry which has been recognized elsewhere is regional dip of strata which tends to produce lateral shifting of the axes of valleys draining parallel to the strike. Powell (1874, 1875) called the asymmetrical valleys of the Uinta Mountains produced by lateral shifting, paraclinal and monoclinal. Davis (1895), Gradmann (1919), Cotton (1926, 1941), Ilyin (1932), and Tomita (1935) recognized the importance of this lateral shifting for subsequent streams in England, Germany, New Zealand, Siberia, and Formosa respectively. Cotton used the term

homoclinal shifting to describe the lateral migration of the stream axis with resulting development of asymmetrical valley cross-sections. Later, Lobeck (1939) in his textbook on physiography termed the process uniclinal shifting but believes that the term was introduced by earlier physiographers (personal communication). Asymmetrical cross-sections of even buried pre-glacial valleys have been described by Kemp (1908). As the result of lateral migration and undercutting by a stream, valleys which drain across the strike should have symmetrical walls, while those draining parallel to the strike should have steeper walls on the down-dip side. If uniclinal shifting were the chief cause of asymmetry, one would expect from the relations of Plate 14 that the direction of rock dip would be about 190°, or that the strike would be about 100°. In reality there is a low regional dip to the south and southeast, which supports the uniclinal shifting theory. Locally, however, small areas have northeastward dips and in these areas the north-facing walls of valleys are steeper than the south-facing walls, just as in areas of southward or southeastward dips. Thus, uniclinal shifting alone cannot be the full cause of asymmetry but it probably is a major contributory factor throughout most of the region.

Asymmetry of some valleys of Indiana, Ohio, and New Jersey was explained by Culbertson (1900) and Russell (1931) as resulting from the protection given north-facing slopes by snow and ice which may remain on the ground all winter, in contrast with the south-facing slopes on which the snow and ice melt first, exposing the slope to sheet wash. This process cannot now be active in the San Diego area because snow and ice is never present in the terrace area.

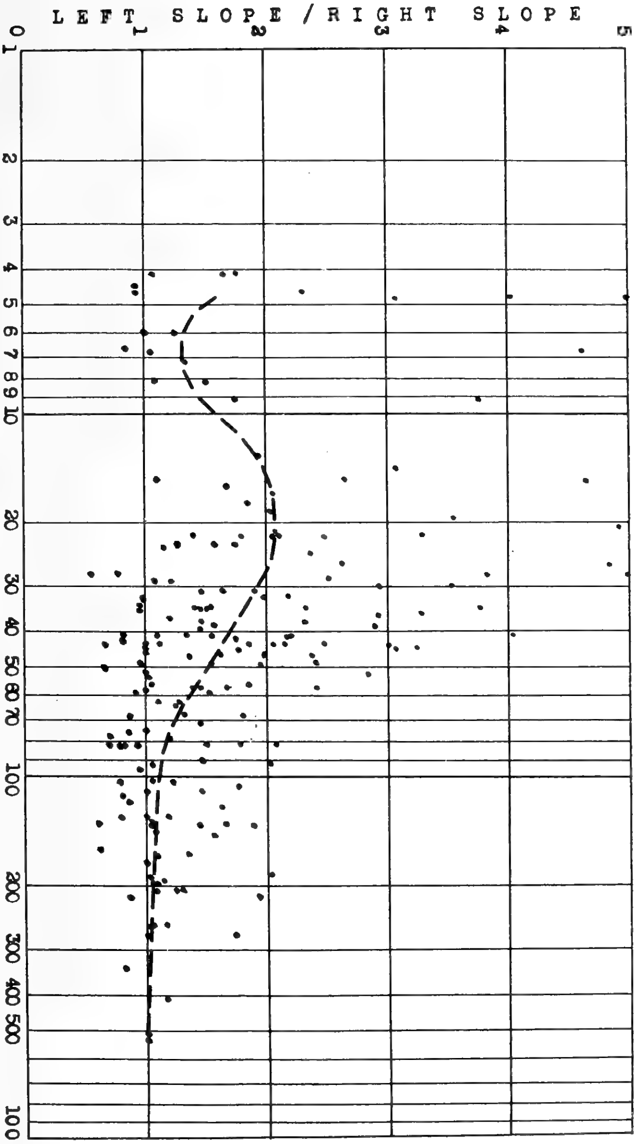
The last remaining suggested cause of asymmetry of valley cross-sections is the effect of vegetation as postulated by Bass (1929) for streams of Kansas, and Bryan and Mason (1932) for streams of North Carolina and South Carolina, and Visher (1937, 1941) for Indiana. Much study has been given also to the general relationship of the rate of erosion and the kind and amount of plant cover by workers of the U. S. Department of Agriculture, as summarized by Bennett and Lowdermilk (1938). In regions where high rainfall is evenly distributed throughout the year sufficient moisture for abundant plant growth may be present on both sunny and shady slopes. In desert areas, the rainfall may be too small for abundant growth except near springs. Between these two extremes there are regions in which the rainfall may be just sufficient to support dense vegetation on slopes where the direct sunlight is present during only part of the day. On the shady side of valleys, where vegetation is dense, much of the rainfall never reaches the ground but adheres to the leaves and evaporates. Rain which does reach the ground loses the effect of impact through having first encountered the shielding vegetation. After reaching the ground,

the water tends to soak into the mantle of partly decayed vegetation and soil from which it may later reach the surface over a long period of time by slow seepage or by upward capillary movement. Much of this water is also gathered by plant roots and returned to the atmosphere by transpiration so that no erosional work is accomplished. Moreover, that part of the rainfall which does run off on the surface is unable to carry with it much sediment because of the ground litter and the strong binding power of the plant roots. In contrast, on slopes not covered by vegetation, the rain first strikes the surface and loosens the component grains. Because the mantle of soil and decayed vegetation is thin or absent and plants are not abundant enough to hold the soil in place, a relatively small amount of water soaks into the ground and nearly all of it immediately becomes surface run-off carrying with it large quantities of sand and mud. In the San Diego region, having a "Humid Mesothermal" climate (Russell, 1926) most of the annual rainfall occurs during only a few storms, each of which commonly is a short period of hard rain, accentuating the proportion of run-off.

Thus, it is probable that the smaller amount of vegetation on the south-facing slopes of east-west trending valleys must result in a higher rate of erosion through sheet wash, eventually causing the development of gentler slopes where exposure to the sun is greatest. This process should tend to develop symmetry indices greater than 1.0 for valleys draining westward; less than 1.0 for eastward drainage; and approximately 1.0 for valleys which drain southward or northward and have wall slopes equally exposed to the sun. Note that this relationship is approximately that shown by the measurements of Plate 14, indicating that variation in density of vegetation may be largely responsible for the development of symmetrical valley cross-sections. For valleys with very steep gradients, the different rates of erosion of wall slopes are probably masked by active downcutting along the axis; this tends to keep both slopes steep.

WALL SLOPES OF SUBMARINE CANYONS

Several submarine canyons have been discovered on the seafloor bordering San Diego County. These have been named Coronado, La Jolla, Scripps, and Carlsbad Canyons. Fairly detailed contour charts of them have been made (Shepard and Emery, 1941). Preliminary examination of their side slopes suggested systematic asymmetry and provided incentive for this investigation as a means of learning more of their origin. Later and more careful study of the symmetry indices measured from the submarine contours and also from sounding lines crossing the canyons revealed some asymmetry, but typically the walls have about equal slopes. The gradients of the submarine canyons are steep, however, and the symmetry of the side slopes corresponds with that of land valleys of equally steep gradients.



Symmetry index plotted against gradient of valley axis. Note that valleys having gradients of about 0°20′ are most asymmetrical and that wall slopes are more nearly equal for valleys having steeper or gentler gradients. Only valleys having azimuths between 245° and 295° are plotted.

PLATE 15

CONCLUSIONS

Asymmetry of valleys cut through a marine terrace in San Diego County was measured for many valleys having various gradients and directions of drainage. Comparison of results with those to be expected from each of the various causes of asymmetry cited in the literature lead to the conclusion that the more abundant vegetation on shady slopes is sufficient to partly protect the shady slopes from erosion, whereas erosion progresses unimpeded on the sunny south-facing wall slopes. This is supplemented by uniclinal shifting in the direction of the regional dip, which, in most of this region, would also tend to form steep north-facing walls. Inasmuch as vegetation and uniclinal shifting should produce approximately similar results, it is difficult to determine their relative effectiveness; however, in a few small areas where lateral shifting alone would develop steep south-facing walls, the north-facing walls actually are steeper, probably indicating the greater effectiveness of vegetation.

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NOTES ON THE EARLY STAGES OF ADELOCEPHALA HEILIGBRODTI f. HUBBARDI Dyar

By JOHN ADAMS COMSTOCK

In the course of field work conducted in the Santa Rita Mountains of southern Arizona in August of 1946 a number of examples of *Adelocephala heiligbrodti* were captured at light. All were of the form *hubbardi,* which Dyar describes as "dark stone-gray instead of pale gray."

A worn female was taken on August 23, which was confined, and laid a number of eggs. A considerable percentage of these hatched, and were carried through to the pupal stage. The following observations were recorded:

EGG: .75 mm. high by 1.75 mm. wide; spherical; flattened; the surface smooth and devoid of all reticulations. Color, bright green.

Eggs which were laid on August 24 and 25 hatched September 3 to 5.

The female from which the ova were secured was taken in the lower part of Madera Canyon at the foot of the mountains where mesquite was the dominant growth. The newly emerged larvae were offered both Mesquite and Palo Verde, and showed a preference for the former. They were therefore reared to maturity on mesquite.

LARVA: First instar; length at end of the instar, 3 to 4 mm. Width of head exactly 1 mm. Body color, green, with a tinge of purple or mauve at the ends of the long processes.

The head is oval, considerably longer than wide. A dark dash occurs on the upper lateral surface of each cheek, and the ocelli are placed on a dark field. The mandibles are black on their inner edges. Placement and relationship of the setae are shown on Plate 16, fig. B.

The larva is very similar to that of *Adelocephala isias* as illustrated on Plate 111, figs. 4 and 4a of Packard's Monograph,[1] except for the long processes arising from the second and third thoracic segments. These are clothed on the shafts with minute hair-like translucent vibrissae, and the tips of the shafts are expanded ovals rather than being triangular as in *isias*.

The body is considerably less in diameter than the head, and in newly hatched individuals tapers caudally.

[1]Memoirs Natl. Acad. of Sciences, IX, Part 2, 1905.

The first dorsal segment bears a long black seta immediately lateral to the mid-dorsal line, and a similar seta occurs dorso-laterally.

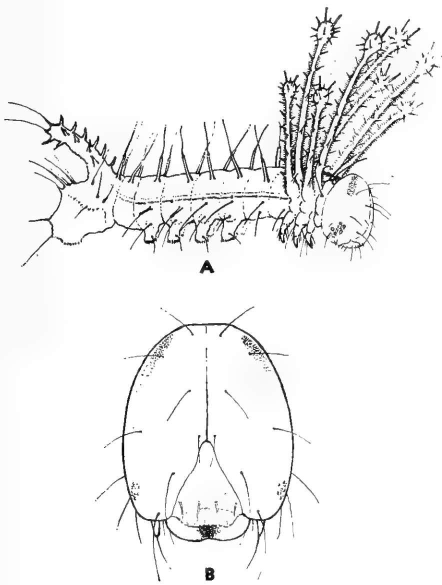


PLATE 16

A. Larva of *A. heiligbrodti hubbardi.* enlarged X 8.
B. Head of same Larva, enlarged X 24.
Reproduced from drawing by the author.

The second and third segments bear each two pairs of long processes, placed dorso-laterally, there being therefore eight of these processes in all on the two segments. The shafts, in addition to their covering of minute hairs, also are clothed with simple spines, and similar spines occur on the expanded oval tips. Two tubular spines occur on the top of each oval, the latter being about twice the length of the simple spines.

In our drawing of the first instar larva, Plate 16, fig. A, each one of the long shafts is shown as separated from its fellow. Actually, when at rest, the larva holds each pair closely appressed, so that there appear superficially to be only four. These processes incline dorso-laterally and slightly cephalad. It will be noted that the most laterally placed process in each pair is shorter than its medially placed fellow.

The larva has a single conspicuous caudal horn bearing numerous spines. On the example used for illustration this horn in-

clined slightly caudally. More commonly however it stands straight up or may even arch slightly forward.

A very narrow brown longitudinal stripe runs in line with the spiracles, and there is a faint indication of a second stripe paralleling it superiorly. The spiracles are minute brown circlets.

Legs and prolegs concolorous with body. Crochets, dark brown.

The placement and character of the setae on the various segments are shown in sufficient accuracy to obviate the need of a description. It will be noted that most of these setae arise from elongate translucent bases. A few however are simple in type.

In succeeding instars there is a gradual change in the character of the long processes. They lose their bulbous tips and become pointed at the ends, the shafts being sparsely clothed with simple spines. They become shorter with relationship to the total length of the body. Finally the secondary spines disappear as such, and each process becomes a stout sharply pointed posteriorly arched horn.

The final instar of this larva was described by Dyar in 1901.[2]

Our observations tally with Dyar's in most particulars, but his numbering of the segments varies with ours in that he counts the head as segment 1, and the thoracic segments are therefore numbered 2, 3 and 4.

Our material included 25 mature larvae which showed a wide degree of variation.

MATURE LARVA: Length, 44 to 50 mm. Body cylindrical; ground color, bright green.

Head averaging 5 mm. in width; color, green, of a slightly yellower shade than body, the surface punctate.

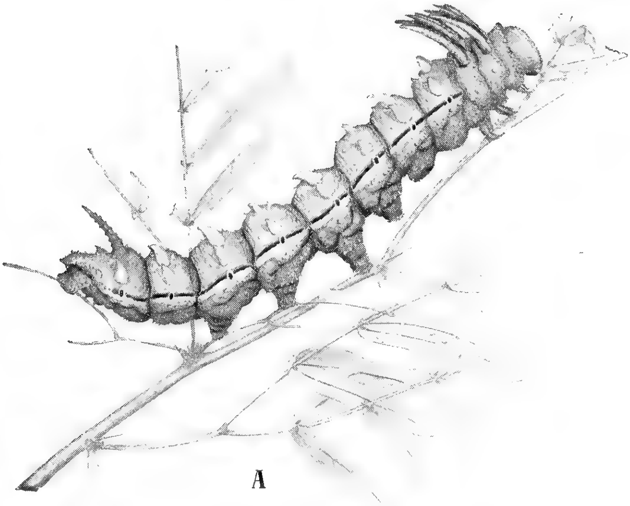
A yellow-white band rises superiorly from a point near the ocelli to the vertex of each lobe. Antennae and labrum white.

First thoracic segment contractile, edged with a row of raised round yellow tubercles placed close together in a straight line. Horns of the 2nd and 3rd thoracic segments (meso- and metathoracic) stout, pointed, recurved caudally, their surfaces slightly roughened by low tubercles. Outer horns green; inner horns tinged with rose, and the sharp pointed tips, white.

Between the two pairs of horns on the 2nd segment there is a transverse row of round yellow tubercles tipped with silver. Dorso laterally on this segment there is a single maroon papillus, and scattered around it a few small yellow tubercules.

The caudal horn of segment 11 (Dyar's segment 12) is stout and is covered with nodules. It is maroon in its lower two-thirds and the tip is green.

[2]Proc. Ent. Soc. Wash. 4: 428-429, 1901.



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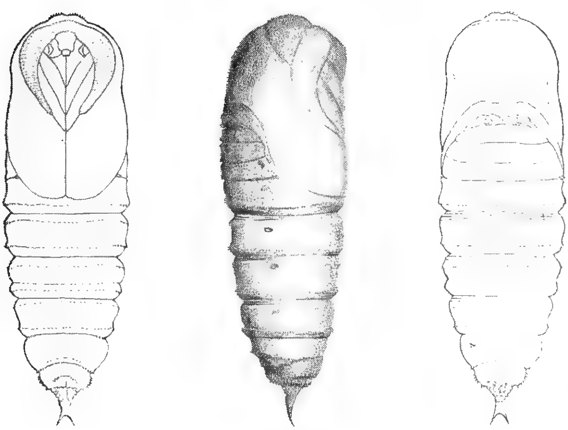


B C D

PLATE 17

Larva and pupa of *Adelocephala heiligbrodti hubbardi.*

A. Lateral view of mature larva enlarged approxim. X 1½.

B.C.D. Pupa, ventral, lateral and dorsal aspects, enlarged approxim. X 1½.

Reproduced from painting by the author.

A dark maroon stripe runs stigmatally from the 4th to the 11th segments. This is narrow and poorly defined in some examples, and very conspicuous in others. Edging this inferiorly is a wide white band tinged on its lower margin in some individuals with yellow.

On each typical segment, from the 4th to the 10th, there occurs an arrow-shaped horn or plate, the point rising superiorly and bending slightly caudad. A row of these is placed slightly lateral to the mid-dorsal line. Each of these horns is a lustrous silver on its outer surface and a bright maroon on its inner aspect. In many examples, however, the horn of the 6th and 8th segments in this series lacks the silver and is reduced in size.

A second row of horns of similar character is placed latero-inferiorly to the first described row.

There is also a single horn of this type placed lateral to the large caudal process on the 11th segment, and a much smaller one occurs on the 12th segment.

Each typical segment has two yellow tubercles on the dorsum in line with the silver horns, and a transverse row of small widely separated tubercles posterior thereto.

The anal shields have large yellow tubercles in irregular rows along the edges.

Spiracles, velvety black. Below the spiracles there are numerous tubercles variously placed and correctly pictured in our Plate No. 17, fig. A.

The abdominal surface is green, slightly lighter in shade than the dorsum, with a scattering of small yellow tubercles.

Legs, green, the distal segments tipped with brown; Prolegs, green, the distal segments darker. Crochets, brown.

Larvae began to go under ground for pupation on October 1, 1946, and continued to do so for some time thereafter owing to the great variation in the rate of growth of different individuals

PUPA: Average length, 30 mm. Width through 4th abdominal segment 9 mm.

The shape and general character of the pupa fits into the key outlined by Dr. Edna Mosher[3] for the Genus *Adelocephala*.

The color is very dark brown with slight tinges of reddish brown except for the glazed eye-piece which is light gray.

The prothorax protrudes slightly forward and is covered with minute papillose points. The same type of rough covering is extended over the mesothorax and face.

The mesothorax bears a pair of nodular protrusions somewhat resembling twisted doughnuts. Antennae, very wide on the ceph-

[3]Bull. Ill. Sta. Lab. Nat. Hist. XLL (II) 144, 1916.

alic half, rapidly tapering toward the rounded tips, and not meeting at the mid-ventral suture. The wings are relatively smooth as compared with other areas.

All of the abdominal segments are finely punctate, and the anterior and posterior margins of the movable segments are set with a transverse row of minute, very short spicules.

Cremaster, bifurcate, slightly recurved ventrally, the tips not hooked. Spiracles concolorous with body, the centers slightly depressed.

Plate 17, figures B, C and D illustrate the ventral, lateral and dorsal aspects of the pupa.

A NEW AND REMARKABLE KEYHOLE URCHIN, MELLITA NOTABILIS n. sp.

By HUBERT LYMAN CLARK

In a collection of shells and dry sea-urchin tests given to the Los Angeles Museum, there were two bare and bleached tests of Mellita, labeled "Mellita longifissa. Florida." It was obvious at a glance that the two were not conspecific and it was further evident that neither was *longifissa*. The smaller is undoubtedly a bare test of the common Florida species, *quinquiesperforata*, but the larger is certainly not that species nor closely allied to it. The extraordinarily small anterior petal, the great thickness of the specimen at its tip and the excessively long posterior unpaired lunule combine to give the upper surface of the specimen an appearance quite unlike any known Mellita, and when the lower surface is examined, the remarkable sculpturing about the lunules confirms the opinion that we have here a quite new species of the long-known genus Mellita. The following description of the bare test is adequate for characterizing the species, in spite of the absence of spines and pedicellariae.

Test rather heavy, 70 mm. long and 78 mm. wide; at the posterior margin it is less than a millimeter thick but at the tip of the anterior petal, the thickness of the test is 10 mm. The slope up from the anterior margin is rapid. Abactinal system, 30 mm. from that margin consists of a madreporite 7 mm. wide and 5 mm. long; the 4 genital pores at its lateral corners are small but distinct. Petaloid area 35 mm. long. 30 mm. wide across petals II and IV and 33 mm. across the tips of I and V; unpaired petal almost 14 mm. long and nearly 7 mm. wide; it is so narrow anteriorly as to be virtually pointed; petals II and IV, 13 mm. long and 8 wide, quite elliptical but tending to be widest distally; petals I and V,

markedly curved, the proximal end about 3 mm. wide, the distal, 9 or 10; the distal end abuts quite abruptly on the proximal end of the lunule. Interporiferous areas in all petals relatively narrow; in petal 3, widest at base, narrowest distally; in the other petals narrowest basally, widest at tip; none of the petals are closed at tip. Furrows forming the petals extremely narrow, the ridges between bearing a single series of 15-20 minute granules; pores present only at the inner end of each furrow—a rather striking feature but comparison with specimens of other Mellitas indicates it is due largely to the degree of weathering the bare test has undergone. Lunules I and V are about 18 mm. long by 1.5 wide, very definitely curved, the concave side towards the midline; lunules II and IV are 14 mm. long, nearly 2 wide and nearly straight; unpaired lunule 25 mm. long, very straight and narrow, little more than 1 mm. wide.

Lower surface remarkably modified by the irregular molding of the paired ambulacra and the margins of the unpaired lunule. Unpaired ambulacrum narrow; a small furrow runs forward from the very small mouth (1.5 mm. in diameter) for about 6 mm., then forks and the slightly diverging furrows extend almost to the margin, giving off one irregular branch on the outer side. Interambulacrum V, definitely outlined by the ambulacral furrows of I and V on each side, making a somewhat bell-shaped area surrounding the unpaired lunule. The four lateral ambulacra mark out irregular, conspicuous areas around the paired lunules, the margins of which are thickened and molded in a most unusual and striking way; the anterior pair are about 32 mm. long by 18-20 mm. wide, while the posterior pair are a trifle longer and narrower. Periproct very small, about 1 mm. in diameter and only 3 mm. back of mouth, in the anterior end of the long furrow. Color of test nearly white as a result of bleaching and weathering.

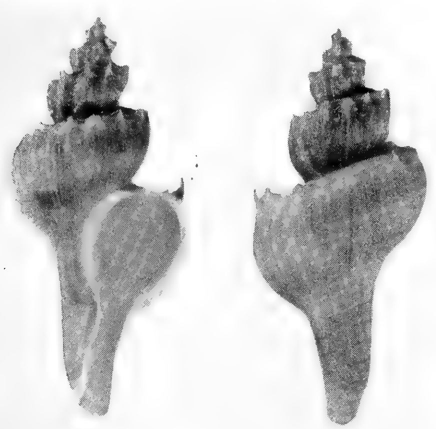
This is one of the best characterized species of Mellita that has yet been discovered and it is fully entitled to the name *notabilis.* The type is in the Los Angeles Museum, but there is no indication of the locality whence it came. The general appearance justifies the opinion that it is related most nearly to *longifissa* and probably comes from the western coast of Central America.

DESCRIPTION OF A NEW SPECIES OF TROPHON FROM THE GULF OF CALIFORNIA

By LEO GEORGE HERTLEIN AND A. M. STRONG

During the course of the Templeton Crocker Expedition to the Gulf of California in 1936 under the auspices of the New York Zoological Society with Dr. William Beebe[1] in charge, a large collection of mollusks was assembled. Reports upon the mollusks collected on this expedition and on those collected on the *Zaca* Expedition the following year have been prepared by the authors for publication in the order of their systematic position. Delay in publication has been unavoidable due chiefly to conditions resulting from the war.

Several requests for information regarding a new species of *Trophon* in the collection have made it advisable to describe the species and make it available for reference. It is here named *Trophon* (*Boreotrophon*) *beebei.*



1 2

PLATE 18

FIGS. 1, 2. *Trophon* (*Boreotrophon*) *beebei* Hertlein & Strong, new species. Holotype, No. 8334 (Calif. Acad. Sci. Paleo. Type Coll.). Height, 52 mm.; maximum diameter, 23 mm.

[1]See Beebe, W. The Templeton Crocker Expedition. II. Introduction, Itinerary, List of Stations, Nets and Dredges. Zoologica, New York Zool. Soc., Vol. XXII, Pt. 1, April 5, 1937, pp. 33-46, text-figs. 1-8.

TROPHON (BOREOTROPHON) beebei, Hertlein & Strong, new species
Plate 18, figures 1 and 2.

Shell thin, pinkish brown, darker on the upper whorls; nucleus minute, white, consisting of 2½ loosely coiled whorls; postnuclear whorls 5, flatly tabulated, with sharp, erect, guttered spines on the shoulder angle, of which 7 show on the first whorl, increasing to 14 on the body whorl; spiral sculpture consisting of faint striation showing most distinctly on the base; axial sculpture of somewhat stronger striations and low, rounded swellings corresponding to the spines, most distinct on the upper whorls; aperture white, quadrate; canal open, moderately long, nearly straight with the tip slightly recurved; inner lip appressed to the base of the last whorl, free along the canal, leaving an umbilical groove. The type measures: length, 52 mm.; length of aperture and canal, 29 mm.; maximum diameter, 23 mm.

Holotype, No. 8334 (Calif. Acad. Sci. Paleo. Type Coll.), from Gorda Banks, southern portion of the Gulf of California, Lat. 23° 01′ N., Long. 109° 28′ 30″ W., dredged in 60 fathoms on a bottom of sand and calcareous algae; a paratype, No. 8335, from the same vicinity, Lat. 23° 02′ N., Long. 109° 29′ W., dredged in 90 fathoms on a rock bottom; also a paratype, No. 8336, from Lat. 23° 01′ N., Long. 109° 27′ 30″ W., dredged in 50 fathoms on a sandy bottom. Paratypes have been deposited in the New York Zoological Society, Department of Geology, Stanford University and San Diego Society of Natural History.

Additional specimens of this species were dredged on Gorda Banks in the vicinity of the type locality at depths of 40-90 fathoms and on Arena Bank at depths of 45-50 fathoms.

Many species referred to *Trophon* or *Boreotrophon* have been described from west American waters. The new species appears to be most nearly comparable to *Trophon* (*Boreotrophon*) *tripherus* Dall[2] which was said to range from the Straits of Juan de Fuca to Piedras Blancas, Lower California. The shell of Dall's species was described as being much smaller than the present form, with less distinctly shouldered whorls, more distinct varices which are scarcely spinose, as well as other differences in the details of shape and sculpture.

This species is named for Dr. William Beebe, director of the expedition during the course of which the type of the present species was collected.

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[2] *Boreotrophon tripherus* Dall, Proc. U. S. Nat. Mus., Vol. 24, No. 1264, March 31, 1902, p. 545. Dredged "off Destruction Island, State of Washington, in 516 fathoms, mud." Bottom temperature 38.2°F. Also dredged off Tillamook Bay, Oregon, in 786 fathoms.—Dall, U. S. Nat. Mus., Bull. 112, 1921, p. 111, pl. 15, figs. 8. 9 (as *Neptunea triphera*).

A CONTRIBUTION TO THE NATURAL HISTORY OF HELMINTHOGLYPTA AROSA ('GLD., BINNEY) AND HELMINTHOGLYPTA NICKLINIANA AWANIA (BARTSCH)

William Marcus Ingram
Mills College, California

This paper is based on one hundred and six individuals of *Helminthoglypta arrosa* ('Gld.' Binney) that were taken from the fifteen acres forming the Duck Cove Club on the shore of Tomales Bay six miles from the town of Inverness. Thirty-eight shells were taken on the tip of Point Reyes from within one hundred yards of the lighthouse up to the Point Reyes Lighthouse parking area. Twenty individuals of *Helminthoglypta nickliniana awania* (Bartsch) were taken in the immediate vicinity of the Point Reyes Lighthouse.

The collections were made on February 8 and 9, 1947. At noon the temperature on February 8 stood at about fifty-one degrees Fahrenheit, and on February 9 at forty-eight degrees. The sky was overcast the greater part of the day on February 8 preceding a moderate rain on February 9.

Helminthoglypta nickliniana awania (Bartsch)

Concerning *Helminthoglypta nickliniana awania* (Bartsch) Pilsbry (1939) states, "It is a race of *H. nickliniana* which appears to have been dwarfed by the conditions of existence on an exposed granitic headland."

Twenty individuals were taken to the right and in the immediate vicinity of the Point Reyes Lighthouse on the top of the cliff as one faces the light going down the long series of steps leading to it. A great many growth stages are represented in the collection, from extremely young shells to fully mature ones. These were found under the buckwheat, *Eriogonum latifolium* Sm., and the Lizard Tail, *Triophyllum staechadifolium* Lang, and under crumbling rock fragments. Both of these plants varied in height from four to eight inches. Pilsbry (1939) reports collections of this subspecies as having been made under *Mesembryanthemum*. Evidence indicates that this subspecies possibly feeds on the fleshy leaves of the buckwheat.

Pilsbry (1939) lists the following measurements for *Helminthoglypta nickliniana awania* (Bartsch): height extremes from 11.4 to 13.9 mm., and diameter extremes from 14.3 to 19.9 mm. The writer's twelve mature shells measure (with the height given

in millimeters first, followed by the diameter): 12.80 by 14.80, 13.60 by 16.70, 14 by 15, 14 by 16, 14 by 16, 14 by 17, 14.50 by 18, 15 by 17, 15 by 17, 15.20 by 17.30, 15.40 by 17, and 16 by 18.

HELMINTHOGLYPTA ARROSA ('Gld.' Binney)

Of the one hundred and six individuals of *Helminthoglypta arrosa* that were taken at the Duck Cove Club all were collected in a partially distended or in an active state. Snails were found under plant cover and in unprotected areas. In the latter situations they were nearly always gathered from small depressions in the ground. Forty-five individuals were found on the ground beneath Poison Hemlock, *Conium maculatum* L., which stood from six inches to eighteen inches in height. Field evidence did not indicate that they were feeding on this plant. Other snails were commonly found in Poison Oak thickets, *Rhus diversiloba* T. & G. One snail was collected in a wood rat's nest.

Three individuals were found laying eggs. All three had worked their anterior extremities into loose soil beneath leaf mold to a depth of half an inch. In one nest, which was opened, there were one hundred and twenty eggs. These were of a light milky-white color and were about 2.30 mm. in diameter. A tough membrane forms the wall of the egg. Two individuals were found copulating in the field.

On the tip of Point Reyes the writer collected nine individuals one hundred yards up the stairs from the lighthouse to the left of the supply shoot. The plants under which they were found were not identified. Seventeen additional individuals were taken beneath *Mesembryanthemum,* Ice Plant, across the road from the Point Reyes public rest rooms. Yet another collection of a dozen individuals was made under unidentified plants across from the Point Reyes parking lot in the vicinity of the Whale's skull.

With the exception of two specimens all were of a mature age group, varying in height from 19.50 to 25 mm. and in diameter from 25 to 31 mm. The two immature individuals measured 6 mm. in height and 11 mm. in diameter and 9 mm. in height by 17 mm. in diameter.

Individuals of this species showed great shell erosion. Three individuals had their shells so badly eroded that about two-thirds of the periostraceum was missing. When first observed these appeared to the writer to be "dead" shells.

The great majority of individuals of *Helminthoglypta arrosa* were placed in terraria at Mills College at room temperature. The terraria bottoms were covered by moist, packed loam soil and capped with wax paper.

On February 14 one pair was observed copulating at 6:45 p. m. Each snail had its penis thrust into the vagina of the other snail;

both sex organs, the vagina and penis, were thrust out of the genital aperture. The vagina of snail A was extended 5 mm., and that of snail B 10 mm. The female copulary organ is translucent, thus allowing the observer to see the penis of one snail within the cavity of the vagina of the other. The penis of snail A was thrust into the vagina of snail B to a length of 3 mm., and the penis of snail B extended into the vagina of snail A to a depth of 2 mm.

The copulating snails were holding to the glass side of a terrarium. The extended copulatory organs forced their heads to the left. One snail had its eye peduncles extended and the tentacles withdrawn, and the other had both its peduncles and tentacles withdrawn.

The mating snails were not observed again until one in the morning of February 15 when copulation had ceased. Both had moved from the side to the bottom of the terrarium. Snail A was lying on its spire with the aperture upturned; the foot was fully extended but the peduncles and tentacles were withdrawn. The copulatory organs were, too, withdrawn. The foot margins were folded upward so that a U-shaped trough was formed in the foot in the region of the mouth opening. Snail B with its head, peduncles, tentacles and copulatory organs still extended had looped its body over the head of snail A, which had apparently taken the vagina of snail B into its mouth. The vagina of snail B was contracting and expanding at rapid intervals; during the time Snail A had snail B's vagina in its mouth snail A also moved the sides of the foot in the mouth area over the vagina of snail B. After a ten-minute observation of this remarkable behavior the snails withdrew from each other. There was no visible damage done to the vagina of snail B by snail A's radula.

Acknowledgment is due the writer's field companions who aided in the gathering of the two mollusks in the Tomales Bay and Point Reyes area, they are, Major Grayson Schmidt, United States Army, Retired; Drs. Herbert W. Graham and Franklin Walker, Mr. Daniel Dewey, and Mr. John Brown. Thanks are due Dr. Richard Wistar who made the collecting possible.

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A PECULIAR NEW CARNIVORE FROM THE CUYAMA MIOCENE, CALIFORNIA

By Chester Stock

Introduction.—In 1938 a few additional remains of fossil mammals were collected in the land-laid Cuyama beds of Apache Canyon, Ventura County, California, by Robert M. Leard of the California Institute of Technology. Among these was a fragmentary portion of a small carnivore skull, identified as belonging to a canid and representing a new genus. Since the relationships of the type were not definitely established, and remained uncertain, it was the intention of the writer to place the description on record in the hope that later investigation might yield additional facts. The war intervened, however, and rather than delay longer, the description is now published, especially since it may be found desirable to refer to the specimen in neogene faunal studies at present in progress.

I have benefited from a discussion of the peculiar characters of the Cuyama specimen with Dr. R. A. Stirton.

Geologic location.—The fossil material occurred at C. I. T. Vert. Paleo. Loc. 64, in Section 2, T. 8 N., R. 23 W., Mt. Pinos quadrangle. Recently, Thomas W. Dibblee Jr., geologist for the Richfield Oil Corporation, informed me[1] that the location places the specimen in what he has designated the "Caliente" formation. This he regards of probable middle Miocene age (Mohnian or Luisian stage according to the foraminiferal sequence in the Miocene of California). There is, however, the possibility that it belongs in the upper Miocene (Delmontian stage).

Mr. Dibblee, who has mapped the area for the Richfield Oil Corporation, states: "The section exposed in Apache Canyon is continental, in which I have differentiated three formations as follows, with tentative names:

"Morales" Formation, Pliocene, gray sand, conglomerate and clays.

"Apache" Formation, upper Miocene, buff-red sand, pebbly sand and gypsiferous red clays. (Equivalent to Santa Margarita formation to west).

"Caliente" Formation,[2] middle Miocene, coarse gray conglomerate, gray sands and red clays. (Equivalent to Monterey formation to west and probably to type Mint Canyon formation)."

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[1] Letters under date of January 17 and 29, 1947.

[2] Not to be confused with, but possibly the correlative of, the strata whence has come the Caliente fauna described by Dougherty (Carnegie Inst. Wash. Publ. No. 514, pp. 109-143, 4 figs., 7 pls., 1940).

As indicated below, the fauna suggests an age for the deposits not so old as middle Miocene.

Cuyama Vertebrate Fauna.—Previous collecting in the area by Gazin[3] and by Wood[4] yielded a fauna which is listed as follows:

Testudinate remains
Avian remains
Canid ? sp.
Citellus (Protospermophilus) quatalensis Gazin
Perognathoides cuyamensis Wood
Perognathus furlongi Gazin
Hypolagus apachensis Gazin
Palaeolagine, gen. and sp. indet.
Mastodont sp.
Merychippus sumani Merriam
Protohippus sp.
Hipparion? sp.
? cf. Plesippus[5]
Camelid sp.
Merycodus sp.

The age relationships of the fauna suggest a Mio-Pliocene stage in the sequence of western Tertiary faunas. Whether the assemblage is early Clarendonian or late Barstovian may be debated. The composition of the fauna, with the exception of one or two forms, leaves the impression that a very late Miocene stage is represented. Gazin commented on the almost total absence of remains of carnivores in the Cuyama fauna. In the face of this fact the present material has added interest, although lack of certain information regarding its relationships curtails at present any direct inferences which may be drawn as to its geologic age. It is described as a new genus and species as follows:

*ACTIOCYON LEARDI, n. gen. and n. sp.

Type specimen.—Portions of snout and palate with teeth, No. 2747 C.I.T. Vert. Paleo., Plate 19, figures 1, 1a.

Generic and specific characters.—Skull small, approximating that of *Cynodesmus thomsoni* in size. Dentition $\frac{3}{}$, $\frac{1}{}$, $\frac{4}{}$, $\frac{2}{}$. Upper carnassial short and wide with no anterointernal cusp, its place being taken by a very well developed cingulum that continues along the inner side of the tooth as a shelf with bordering crenulate edge but is more moderately developed from about the middle of the crown to the rear of the tooth. $M\frac{1}{}$ is subtriangular in shape with hypocone crescent short, protocone a low anteroposteriorly

[3]Gazin, C. L., Carnegie Inst. Wash. Publ. No. 404, art. 6, pp. 55-76, 5 figs., 4 pls., 1930.

[5]This identification is based on a large calcaneum found by Dr. Wood. It is dfficult to reconcile the presence of Plesippus with the Cuyama fauna as now known. The possibility that the specimen represents a large hypohippine form might be further explored.

*Áktlos, pertaining to the coast; kúwv, dog; the species is named for Robert M. Leard, who collected the specimen.

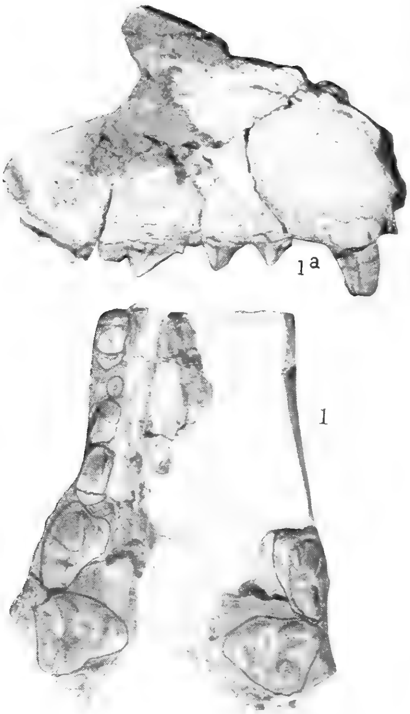

PLATE 19

Figs. 1, 1a. *Actiocyon leardi* n. gen. and n. sp. Skull, No. 2747 Calif. Inst. Tech. Vert. Paleo. Coll.; fig. 1, palate and occlusal view of teeth; fig. 1*a*, lateral view; nat. size.
Cuyama Miocene, California.

extended crest, metaconule very small, paracone and metacone connate, external cingulum present. The imperfectly preserved M^2 is small, crown evidently reduced in size with metacone only a tiny cusp in comparison to the paracone.

Canine with root relatively large for size of crown. External face of crown with well marked longitudinal groove. P^1 is single-rooted with crown not preserved. P^2 is small, two-rooted, with simple crown having no accessory cusps. P^3, noticeably larger than P^2, likewise with simple crown and with extended posterior base.

Description.—When specimen *2747* was collected in the field there was definite evidence of the presence of three incisor teeth on the right side of the snout. These teeth were small, poorly pre-

served, and were evidently lost before the specimen was prepared in the laboratory. For the size of its crown, the upper canine has a heavy, almost bulbous root. The crown of the canine is convex externally with the internal face flattened. In *Potos* and in *Nasua* the canine shows greater transverse flattening of the crown. A well marked longitudinal groove occurs on the outer face similar to the grooves seen in the canine of *Potos*.

Crown of P^1 is not preserved, but the anteroposterior length of the cross-section of root is 2.7 mm. In both P^2 and P^3 the tip of the cusp is blunt, not sharp, and lies in the fore half of the crown. There is no posterior accessory cusp. A cingulum occurs along the lingual side of the crown in these teeth, and is more in evidence in P^3 than in P^2. A faint external cingulum occurs in P^2 and P^3.

Actiocyon is characterized especially by the small thick carnassial for the latter is wide for its length. The tooth possesses at the anterointernal corner in place of the protocone a well developed shelf or cingulum. This shelf reaches backward to a point below the notch between paracone and metacone where it continues as a well marked cingulum to the posterior end of the crown. There is no tendency to project the anterointernal corner in front of the anterior level of the crown as in *Cynodesmus* or *Cynodictis*. However, the anterointernal edge of the shelf thickens, and a similar thickening, but extending for a slightly longer distance, is seen immediately behind. This latter thickened edge is divided by a notch into two parts. The blade-like metacone is short. The tooth reminds one of the procyonids, but the two inner cusps present in *Phlaocyon* and *Procyon* are unlike the thickening of the edge of the inner shelf noted above in the Cuyama specimen.

In M^1 the outer cusps have a full connate development with metacone visibly smaller than paracone. While an external cingulum is present, the summits of the outer cusps are not removed to so great a distance from the outer edge of the crown as in earlier dogs. The protocone is a wide crescent-shaped cusp, the protoconulu barely discernible, and the metaconule is relatively small. The hypocone is narrow transversely. The narrowness of the inner side of M^1 gives this tooth a subtriangular configuration. Unfortunately, M^2 is only partly preserved. Enough of the crown remains to show that the tooth was reduced in size with the metacone a tiny cusp. It is evident that this tooth was wider in an anteroposterior direction across its mid-section than across the outer side. When the skull fragment is viewed from the side (Plate 19, figure la) the tooth is seen to have a position above the level of the tooth row. This may be in part due to the state of preservation of the specimen.

The fragments of lower jaw in the Cuyama collection, referred questionably to a canid by Gazin, include a specimen (No. 65

C.I.T.) in which $P_{\overline{4}}$ is preserved. This tooth is narrower than $P_{\overline{3}}$ in *Actiocyon.* Moreover, what is left of $M_{\overline{1}}$ and the alveolus for this tooth give evidence of a narrower, more slender, lower first molar than that which would be expected if No. 65 belonged to *Actiocyon.*

MEASUREMENTS (IN MILLIMETERS) OF No. 2747

Anterior end of C to posterior end $M^{\underline{2}}$	51.4
C, anteroposterior diameter	6.8
C, transverse diameter	4.6
$P^{\underline{2}}$, anteroposterior diameter	5.8
$P^{\underline{2}}$, transverse diameter	2.9
$P_{\overline{3}}$, anteroposterior diameter	7.6
$P_{\overline{3}}$, transverse diameter	4
$P_{\overline{4}}$, anteroposterior diameter	11.6
$P_{\overline{4}}$, transverse diameter	8
$M_{\overline{1}}$, anteroposterior diameter along outer side	11.1
$M_{\overline{1}}$, transverse diameter normal to outer side	11.9

Comparisons.—Actiocyon appears to resemble most closely in its curious characters the European canid *Alopecocyon.*[6] This genus was originally described under the generic name *Alopecodus* (preoccupied) by Viret,[7] the genotype being *Cephalogale gaillardi* Wegner. The latter species and associated fauna were first described by Wegner[8] from upper Miocene deposits near Oppeln in Upper Silesia. The species occurs likewise in the Miocene of La Grive Saint-Alban (Isere).

The available material of this form are maxillary fragments with teeth permitting comparison with the Cuyama specimen. Evidently there is resemblance between the Californian and European forms in size, although the former is slightly larger. $P^{\underline{3}}$ is with simple type of crown in both, and the relation in size of that tooth to $P^{\underline{4}}$ is likewise comparable in the two genera.

Of particular interest is the upper carnassial in *A. gaillardi.* As figured by both Wegner and Viret, the length of $P^{\underline{4}}$ is only a trifle more than the length of the outer side of $M^{\underline{1}}$. $P^{\underline{4}}$ is shown in Wegner's figures as lacking an anterointernal cusp (protocone) and in its place is a well developed cingulum which swings around from the front face of the tooth and extends along the inner side to the posterior end. In the text Wegner describes the inner side of $P^{\underline{4}}$ as follows: Auf der lingualen Seite geht der weit ausgezogene Basalwulst zu dem Ansatz eines niederen Innenhöckers (Deuterocon) über. In the figures given by Viret the same construction of $P^{\underline{4}}$ is seen.

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[6]See Camp, C. L. and V. L. Vanderhoof, Geol. Soc. Amer., Spec. Paper No. 27, p. 320, 1940.

[7]Viret, J., Trav. du Lab. d. Geol. Lyon Univ., fasc. 21, mem. 18, p. 9, pl. 2, figs. 1-4, 1933.

[8]Wegner, R N., Palaeontographica, Bd. 60, pp. 226-227, pl. 12, fig. 25, 1913.

P^4 in *Actiocyon* appears to possess a greater thickness across paracone and metacone than in *Alopecocyon gaillardi.* Also, the inner platform with its crenulate inner edge has a somewhat different shape from that in the European genus. Similarity of cusp arrangement in the first upper molar is evident when the two genera are compared.

On the basis of some of the characters displayed particularly by P^4 and M^1 *Actiocyon* shows some resemblance to the Procyonidae. The genus may represent an aberrant type of dog that has secondarily acquired some procyonid characteristics. No. *2747* lacks however the well developed inner cusp seen in the upper carnassial of living and extinct procyonids. P^4 and the molars posterior to this tooth have not acquired the breadth seen in *Potos* or *Nasua*. In the reduced size of M^2 No.*2747* is more like *Bassariscus* than like *Procyon.*

Actiocyon differs markedly from the specimen referred to *Cynarctus crucidens* by McGrew[9] in the peculiar features of carnassial already described, in the subtriangular shape M^1, and in the much more reduced size of M^2. *Aletocyon* of earlier Miocene age than *Actiocyon* differs likewise from the latter in the better developed inner cusps of P^4, broader M^1, and relatively larger M^2. No special resemblance is seen to the South American genera *Pachynasua* and *Brachynasua.* It has not been possible to compare the Cuyama type with other fossil forms from South America.

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[9]McGrew, Paul O., Geol. Ser. of Field Mus. Nat. Hist., vol. 6, no. 22, p, 329, fig. 89, 1938.

Division of the Geological Sciences,
California Institute of Technology,
Contribution No. 414.

Ford Ashman Carpenter

1868-1947

Dr. Ford Ashman Carpenter, one of the pioneer members of the Southern California Academy of Sciences, passed away in Los Angeles on November 10, 1947.

Dr. Carpenter served as President of the Academy from 1929 to 1931, and as a member of the Board of Trustees for many years. He was a Fellow of the Academy, and represented our organization on the Board of Governors of the Los Angeles County Museum for several terms.

He was born in Chicago, Illinois, March 25, 1868, the son of Lebbaeus Ross and Charlotte (Eaton) Carpenter, and received his education at Dilworth Academy. He had technical training at

Carson Astronomical Observatory, and the U. S. Balloon and Airship Schools. He was granted an LL.D. degree by Whittier College in 1913, and a Sc.D. by Occidental College in 1921.

Dr. Carpenter saw long service with the U. S. Weather Bureau at various stations before becoming manager of the Department of Meteorology and Aeronautics of the Los Angeles Chamber of Commerce. He was a prolific writer of technical papers, a number of which were published in the Academy "Bulletin." He was also an inventor of several meteorological instruments.

The many important positions of trust which he held, and the numerous and diverse activities in which he was engaged are in part listed in "Who's Who in America," and in "American Men of Science." These biographical sketches bear evidence of Dr. Carpenter's numerous talents and capabilities, and his strong urge to be of service to mankind.

J. A. C.

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Began issue with Vol. 1, No. 1, January, 1902. Issued ten numbers in 1902; nine numbers in 1903, 1904, 1905; three numbers in 1906. Issued two numbers annually from 1907 to 1919, both inclusive (except 1908—one issue only). Issued four numbers (January, May, July and October) in 1920.

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508

BULLETIN OF THE
Southern California Academy of Sciences

LOS ANGELES, CALIFORNIA

VOL. XLVI SEPTEMBER-DECEMBER, 1947 PART 3

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VOLUME 46 - - - - - - - PART 3, 1947

LATERAL LINE SENSE ORGANS IN SALAMANDERS

By WILLIAM A. HILTON
Department of Zoology, Pomona College

The first published observations on these organs was by Stenonis in 1664, dealing with the skate. In 1861, Schultze found homologous structures in gilled salamanders. These neuromasts in amphibians were found to retain a primitive condition in the surface layers of the epidermis. Some of the early observations on them were by Leydig '68, Schultze '70, Langerhans, '73, Bugnion '73, Malbranc '76 and Wiedersheim '93. The last two studied the structure and distribution of the organs in *Proteus, Cryptobranchus, Triton, Salamandra* and *Salamandrina. Wiedersheim* '93, says the sense organs become covered with epidermis or epidermal cells during their periods of land existence and that they are uncovered when the animals take to water again. Certain it is that land forms show little indication of neuromasts. Among the many species and individuals which I have examined, some show nothing of these organs, while others of the same species may have abundant indications of them. I have found no sign of them in adult land forms although many specimens have been studied. When they are not seen in the adult however, it does not mean that they are not present in some form, but it does suggest that they are not completely functional.

Cope, '89, described depressions which he called mucous pores, in a number of amphibians, but he confused these with sense organs. The latter occur in groups and in linear arrangements and are usually regularly and symmetrically disposed on head, body and tail. At times they are difficult to locate or identify, especially when dermal gland are about the same size, but they may usually be told by differences in size, form and arrangement. They are often distinguished in the head region when not seen other places.

The last work I have been able to find dealing with the distribution of these sense organs is that of Kingsbury 1895, but Theis '32 has a brief consideration of their early formation in *Salamandra.* The group as recognized by Kingsbury and often quite evident are as follows:

On the upper side of the head, on each side:

Supra-orbital, usually starting near the nostril; it may continue back of the eye.

Infra-orbital, usually starting near the nostril and continuing under the eye.

Post-orbital, back of the eye. It may be joined by the last two mentioned. It may also run down on the side of the head.

Occipital, on the back part of the head above.

On the more lateral sides of the head each side may show:

Infra-orbital and Post-orbital which are also partly seen above and;

Angular, above the corner of the mouth. (Seldom distinct).

Jugular, back from the corner of the mouth on the side of the head.

Oral, just under the line of the lower jaw.

On the under side of the head the following may be seen:

Jugular and Oral, often better seen from below than from the side, and,

Gular, one or more rows of areas either side of the middle line below.

On the body the following:

Dorsal, usually from the back of the head down the back. Sometimes this seems to be contained on the tail, but frequently it is represented by a few areas not far from the head.

Lateral, this is usually the best developed of any of the body areas. It may be confined to the body region or in some cases appear to be continued on the tail.

Ventral, this runs between the front and hind legs, usually in quite a ventral position.

Areas on the tail:

There is usually one row of areas in a dorsal position, sometimes apparently continuous with the dorsal row, but more often it seems to be a continuation of the lateral body row of areas. Sometimes there seem to be a few in a dorsal row in addition to a better marked lateral row. In any case the line almost always becomes quite dorsal as it extends back on the tail.

For the most part the neuromasts seem to be spherical in shape and in sections resemble taste-buds in appearance. Theis '32, describes their early development as little groups of cells with a central one from which the sensory cells are formed. I have found such stages in a number of embryos and early larvæ of several species. Externally these neuromasts appear as small circular or elongate areas, often slightly depressed. In most of

the more elongate spots there are two or more neuromasts. Sometimes several are grouped in one irregular spot, often two or more are near, a group arrangement which may be repeated a number of times, especially on the body.

Proteidæ

Proteus was studied by Bugnion '73, Malbrane '76. Kingsbury '95 describes them in *Necturus.*

In these genera the conditions are similar. Individually the areas are elongate depressions in the skin.

In several specimens of *Proteus* which I have examined, I found the areas in the head region more longitudinally disposed than the usual arrangement in other species and harder to separate into groups. In the head of

Necturus the areas are more isolated and so more distinct.

In these the lateral line is marked and extends on to the tail, the dorsal is slight with, in *Necturus,* a different angle. The ventral line is similar to the lateral but found only between the limbs.

Sirenidæ

In *Siren,* the areas are elongate but typical in arrangement in head, body and tail. The dorsal line is more extensive than in *Necturus,* but like it the lines are at right angles to the lateral line.

In an example of *Pseudobranchus,* there was difficulty in locating the areas. Those that I found were circular in outline.

Amphiumidæ

Here the areas were also found to be elongate in *Amphiuma,* but typical in distribution on the head and so far as I could tell on the body. I could not trace them well on the tail. On the whole the areas had a more linear arrangement than was usual.

Cryptobranchidæ

The distribution of the sense organs in *Cryptobranchus* have been described by Malbranc '76, Cope '89 and Kingsbury '95. In the adult these organs are open circular or oblong pits on elongated dermal papillæ, often there are two neuromasts in each spot or papilla. They are abundant and typical on the head; the dorsal line is weak with about 10 or 12 transverse organs which are continued to near the hind legs. The lateral line is just dorsal to the lateral fold and extends to the tip of the tail. On the head the Post-orbital series seems continuous with the last. The ventral line contains about 36 organs. It extends from in front of the legs, where it curves ventrally, to just before the hind legs. In larvæ of

Cryptobranchus the areas are similar, but nearly circular in outline.

In an adult *Megalobatricus*, so far as could be determined, the conditions were similar to adult *Cryptobranchus.*

Hynobiidæ

In several adults of *Hynobius,* no signs of dermal sense organs were found except a few faint regions on the head, just back of the eyes. None were seen in *Onychodactylus.* One out of three specimens of *Batrachuperus pinchonii,* showed eight faint areas on the head, back of the nostrils and above the eyes.

Amblystomidæ

Amblystoma maculatum. Adults when clear may be quite typical, but many individuals show little or nothing; some have areas only on the head. Larvæ are quite typical. In one of 16 mm. they are less abundant than later, there are few on the tail in this and the lateral body line has slightly elongate spots. In a larva of 28 mm. the areas are typical in distribution with double and triple spots on the body and tail.

A. annulatum. Several adults showed little or nothing of the sense organs. Larvæ of 45 mm. total length, were typical in the head region with ventral and lateral body rows with each 2 to 3 spots for each segment and several areas on the tail with 2 spots each.

A. tigrinum tigrinum. A number of specimens showed few if any areas. Some had slight indications of areas in the head region. Large larvæ were in general typical in arrangement, elongated on head and body with several sense organs in each.

A. t. nebulosum. Several had a few spots on the head.

A. californiense, A. jeffersonianum. A. Talpoideum, none seen.

A. opacum, none seen although many examined.

A. gracile, typical on the head; none seen on the body.

A. texanum, usually seen on the head, sometimes just about the eyes; in others quite typical. Sometimes the ventral side of the head has but one row of about 5 sense organs on each side. None found on the body.

A. macrodactylum. None found in the adult, many specimens examined. In larvæ of 30 mm. the sense areas are well marked in small groups, the head region rather typical; on the sides of the

body and tail a single line of areas with from one to three spots in each, extends from the head to the tip of the tail.

Rhyacosiredon altamirani. Faint but quite numerous spots in front of the eye, slight signs on body and tail.

Rhyacotriton olympicus. Well-marked, typical in position but not numerous; adults and larvæ about the same. An adult had 9 or 10 on each side of the head dorsally and about 10 on each side of the head region ventrally. In this specimen there were 5 dorsally on the body on each side, about 12 that were lateral and 9 ventral; the tail had about 5 dorsally on each side.

Dicamptodon ensatus. None was found in the adult of several specimens. The larvæ as far as determined had a typical arrangement, the areas were elongate like those of *Proteus, Necturus, Siren* and *Amphiuma.*

Salamandridæ

Triturus viridescens viridescens. Aquatic adults were quite typical with the areas well developed. Other eastern U. S. representatives of the genus *Triturus* were much the same as far as determined.

Triturus torosus. In some cases, sense areas not seen, in others a typical arrangement.

T. granulosus granulosus. In some adults quite a typical arrangement. In one for instance the head above quite typical with in all about forty areas on each side above and thirty-five on each side below, with 6 dorsal body areas with 1 or 2 spots in each and 11 lateral spots, many grouped 2 by 2, and 12 ventral spots 2 by 2. On each side of the tail about 12 spots in groups of 1, 2 or 3.

T. g. mazamæ, quite typical; late larvæ and adult similar; dorsal areas and caudal, each with individual sense spots. On the body 4 dorsal, 10 lateral, 9 ventral. Tail 7 on a side.

T. klauberi, none seen in specimen examined.

T. vulgaris, not easily seen on body, head above typical, about 40 on a side, but only 2 or 3 on a side ventrally.

T. alpestris, similar to *vulgris,* but more on ventral side of the head, or about 10 on a side in specimens examined.

T. cristatus, in some not well shown, a female was typical, head above few, 6 on a side ventrally. On body 2 faint rows, a lateral of 11, a ventral of 5, 7 faint ones on the tail each side.

T. m. marmoratus, none seen in specimens examined.

Euproctus platycephalus, none seen in specimens examined.

Pleurodelides watli, typical and well developed; the head above on one side 60 spots, ventrally 40 on a side. Body areas well marked. A dorsal row from 1 to 4 vertically arranged spots in each area or about 24 in all. Lateral line 11 areas 1 to 3 spots in each or about 24 in all; ventral row 10 or 11 areas, 2 to 3 spots in each or about 25 in all. As contrasted with the dorsal, horizontal.

Cynops pyrrhogaster. Many examined, some typical, others faint. On head above 38 on a side, 35 on a side ventrally of which 3 or 4 on a side were on the lower side of the upper lip not far from the nostrils.

Tylototriton andersoni. In an adult of this no sign of the sense organs was found.

Pachytriton brevipes. In several specimens, the sense areas were found rather typically but faintly on the head but not on the body. In one there were 30 on each side of the head and 11 ventrally.

Salamandra maculosa and *S. atra,* adults, none found.

Plethodontidæ

In this family the sense areas were fewer and less marked than in Salamandridæ and Amblystomidæ. Even in larvæ it was often difficult to make them out and yet one genus has the most conspicuous sense organs for its size of any salamander and it is a member of this family.

Typhlomolge rathbuni. Numerous and typical on the head, but small and hard to locate. About 35 on each side of the head both above and below. Lines on the sides of the body not perfectly typical. About 20 areas in all in two or three poorly defined rows. About the same number on the tail, mostly a continuation of a poorly represented lateral row.

Typhlotriton spelæus. No clear evidence of areas in adults. On the head of a larva there were about 20 on a side above and 11 on each side below. Median line on body and tail, dorsal and ventral lines not well represented on the body or tail.

Desmognathus fuscus fuscus. Some specimens show little signs of sense organs, others only on the head. Never conspicuous or abundant. One specimen had 10 on each side of the head above and 8 on a side below. On the body the dorsal line is usually poorly represented, the ventral line a little more marked, the lateral line faint but with continuous spots which are continued a short distance on to the tail.

D. f. auriculatus, D. f. brimleyorum, D. o. ochropкus, D. o. carolinensis, D. phoca, and *D. wrighti,* similar to above.

D. quadramaculatus quadramaculatus. In this species I found the clearest picture in the genus if not in the whole family, with one or two exceptions. There were about twelve on the head on each side above and fifteen on each side ventrally of which last 7 were in the lower side of the upper jaw. On the body dorsally the row was short with about 7 spots on a side; there were about 12 well-marked sense spots laterally between the legs and a ventral row also between the limbs of 10 to 12 well-marked sense spots. The tail on each side had a row of about 15 sense spots.

Leurognathus was much like *Desmognathus* in the adult, but the larvæ being quite large were more typical than most of the larvæ of *Desmognathus* examined.

The following species of Plethodon were examined sometimes with many examples and in all of these, young and adults, in the adult stage not a single clear sense spot was found in the skin:

P. c. cinereus, P. c. dorsalis, P. dunni, P. elongatus, P. glutinosus. (A large number examined of many sizes but no sense areas seen).

P. g. shermani, F. hardii, P. Idahoensis, P. jordani, P. metcalfi, P. nettingi, P. richmondi, P. vandykei, P. vehiculum, P. weherlei, P. welleri, P. yonahlosse.

Other species examined with negative results were:

Plethopsis wrighti, Hemidactylum scutatum, Manculus quadriditatus, and most of the species of *Batrachoseps,* all the species of *Aneides,* most of the subspecies of *Ensatina.*

In the adults of *Eurycea* a few sensory spots were found in the head region and in larvæ. Some adults examined were as follows:

E. bislineata bislineata. Some showed little or nothing of the sense spots. One had 7 on one side of the head above and 3 on a side below. Another had 8 on a side above and none below but three marked spots below just back of the head.

E. b. cirrigera. Like T. b. b. faint.

E. b. wilderi, none seen in several specimens.

E. longicauda longicauda. Most show nothing but one had three in front of the eye on each side with five on a side below. Another had three in front of the eye and two under the eye, on each side.

E. l. guttolineata. Most show nothing, others a trace.

E. l. melanopleura. Most show little, one had 10 on the head above on one side and 6 on a side below.

E. lucifuga, nothing seen in a number of specimens.

E. multiplicata. One had 8 on a side on the head above and 8 on a side below. Larvæ were rather typical in distribution of sense areas but not marked.

E. neotenes and *E. nana.* These had the larval condition but the areas were not conspicuous. A specimen of E. nana had 15 on a side on the top of the head and about 24 on a side below.

Hydromantes platycephalus and *H. genei* showed no sensory areas in several specimens examined.

Pseudotriton ruber ruber. Adults show a typical arrangement of areas but they are not conspicuous. The rows may be made out along the sides of the body and one to two rows on the tail but the spots are not numerous. Other species of the genus examined are similar but individual variation was too great to distinguish differences. *P. r. vioscai* was similar in a number of specimens. One of these had about 15 spots on the head above on each side and about the same number below.

Gyrinophilus porphyriticus porphyriticus is quite typical in the larva, as shown by Kingsbury but weak in the adult. One specimen had about 12 areas dorsally on each side of the head and about the same number below. Areas on the body were not clearly seen.

G. danielsi danielsi. Similar to the last with about the same number of sensory spots and like distribution in the head region.

Stereochilus marginatus. Cope '89, figures the sensory areas in this species, but does not show quite all that may be found in the head region. In specimens at hand, the body areas were like those of the head in appearance with the usual distribution, but the skin was so wrinkled that I could not plot them perfectly. The head above on one side had 20 areas. The post-orbital group was not well developed. Ventrally there was but one row of spots on each side with about 11 in each row. These spots which are quite depressed were unusually large and prominent. Sections examined under high magnification revealed them as true neuromasts, not slime pores.

Examples of the following Mexican and Central American genera of the family Plethodontidæ were studied:

Pseudoeurycea, Chiropterotriton, Magnadigita, Bolitoglossa, Thorius, Oedipina and *Oedipinola.* No indication of skin sense organs were found in any of these.

SOME CONCLUSIONS

1. Neuromasts are found in all the families of salamanders.
2. These sense organs are more or less spherical as individuals

and usually are arranged in a linear manner. Sometimes they may seem to form depressions. Sometimes several neuromasts are grouped together.

3. They have a regular and usually a symmetrical distribution.

4. They are found especially in larvæ and aquatic forms.

5. They are impossible to locate or not easily recognized from the surface in land forms and they may not appear in some species which are somewhat aquatic in the adult.

6. The most primitive type of sense organ in the skin seems to be the elongate, short line type, such as found in *Necturus, Proteus. Siren, Amphiuma* and in the larvæ of *Dicamptodon.*

7. When the areas are well developed, definite areas may be seen on head, body and tail.

8. Often the sense areas may be found on the head when they are not clear on the body and tail.

9. The sense spots are poorest developed in the family *Plethodontidæ.* Some others such as especially the Hynobiidæ and members of the Salamandridæ and Amblystomidæ, so far as studied have many species where the organs are not marked in the adult.

10. They are the largest in proportion in *Stereochilus.*

11. The genera—*Plethodon, Ensatina, Batrachoseps, Hemidactylum, Manculus, Hydromantes, Plethopsis* and *Aneides* do not seem to have these structures in the adult. Most of them, so far as known have no aquatic larval stages.

12. Some species of Salamandridæ, Amblystomidæ and Plethodontidæ sometimes show these structures in the adult in some specimens, but not at all in other individuals.

13. Not all aquatic forms show these sensory spots in the adult but all aquatic larvæ so far as known, possess them.

14. No sensory spots were found in any strictly land forms.

15. When the tail of a salamander is cylindrical, sensory spots were not found.

16. When the tail is somewhat compressed, that is flattened from side to side, the sensory spots are usually evident, either on the head alone or on both head and body.

17. No cases were found where sensory spots were found on the body alone, although there were many individuals where they were found on the head alone.

18. Usually there are three lines of areas along the body where these sensory spots are located, especially in larvæ, but there are exceptions. Some larvæ have apparently but one line although this is usually with several spots in each area.

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EXPLANATION OF FIGURES

PLATE 20. Distribution of lateral line sense organs in the families Proteidæ, Sirenidæ, Amphiumidæ, Cryptobranchidæ and Hynobiidæ. 1, 2 and 3—Upper, lower and lateral views of the head. *Proteus.* 4, 5, 6 and 7—*Necturus* adult. Body from the side and head from below, the side and above, 8, 9 and 10—*Siren* adult, side of the body and head from below and above. 11, 12 and 13—*Amphiuma*, adult head from below, above and the side. *Cryptobranchus*—14 and 15. From a specimen of 30 mm. length, side of the body and head below. 16—A specimen of 40 mm. length from above. Both stages are larval. 17—*Batrachuperus* head above.

PLATE 21. Families Amblystomidæ and Salamandridæ. 1, 2 and 3—*Amblystoma maculatum* larva of 28 mm. Side body, head from above and below. Partly from Kingsbury. 4—Larva of *Amblystoma annulatum* of 45 mm. from the side. 5 and 6—*Amblystoma tigranum tigranum*, full grown larva. Body from the side and head below. 7, 8 and 9—*Amblystoma maculatum* adult, from side, head below and above. 10, 11—*Rhyacotriton olympicus* adult above and below. 12, 13—*Dicamptodon* head above and below. 14, 15 and 16—*Triturus granulosus granulosus*, from the side and head above and below. 17, 18, and 19—*Pachytriton brevipes*, head above, below and from the side. 20, 21 and 22—*Pleuridelides watli*, from the side, head above and below. 23—*Triturus cristatus*, head above. 24—*Triturus alpestris*, head above. 25—*T. v. viridescens*, head above. 26—*Triturus vulgaris*, head above. 27, 28 and 29—*Cynops*, head from above, below and the side.

PLATE 22. Members of the family Plethodontidæ. 1, 2 and 3—*Desmognathus fusca*, side of the body, head above and below. 4—*D. q. quadramaculatus*, partly from the side and above. 5 and 6—*Typhlotriton spelaeus*,, late larva from above and head below. 7, 9, 10—*Typhlomolge*, adult from the side, head below and above. 8—*Pseudotriton r. ruber* from the side. 11 and 12—*Gyrinophiius p. porphyriticus* adult, head below and above. 13 and 14—*Eurycea longicauda melanopleura*, head from below and the side. 15, 16 and 17—*E. l. longicauda*, head above, from the side and another above. 18, 19 and 20—*Stereochilus marginatus*, head above, below and from the side. 21, 22 and 23—*E. b. bislineata*, head above, from the side and below. 24, 25—*Pseudotriton r. vioscai;* head above and below. 26 and 27—*Pseudotriton r. vioscai*, head above and below.

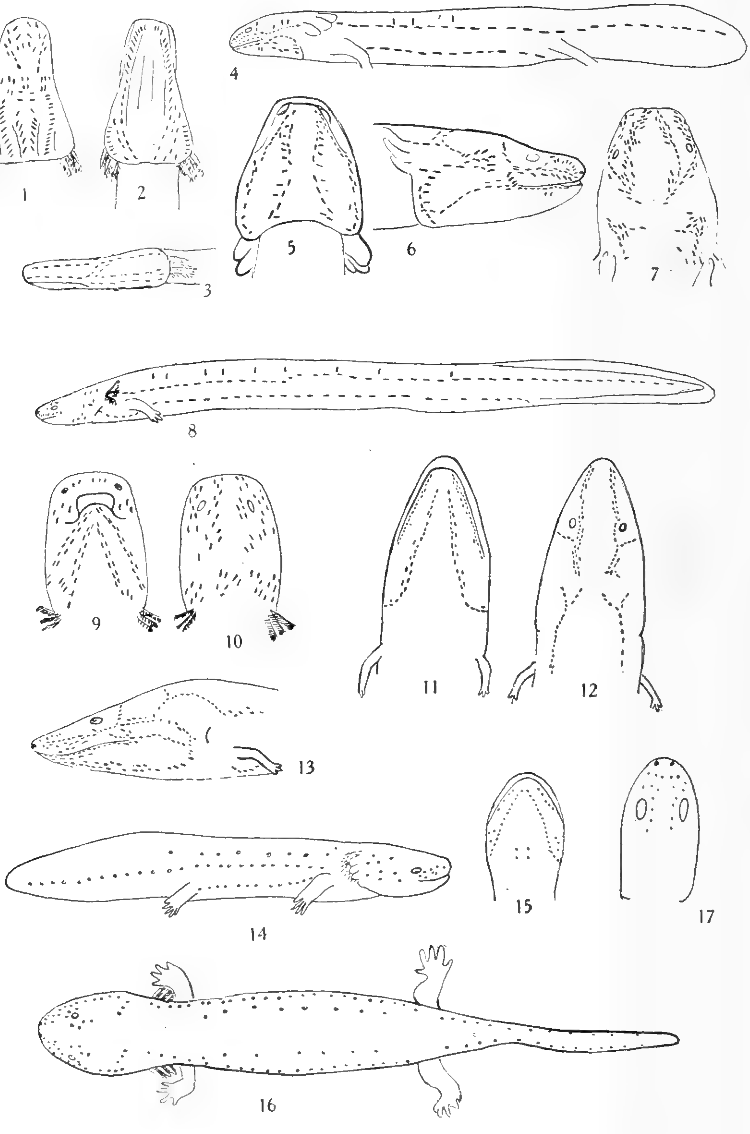

PLATE 20

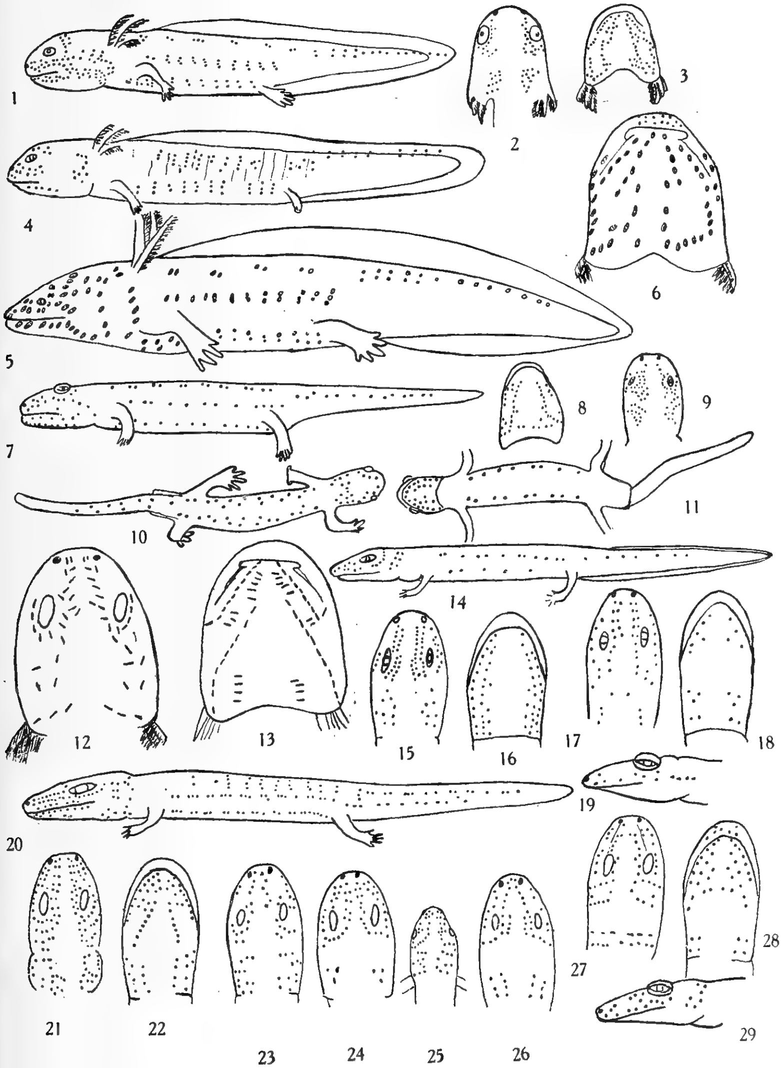

PLATE 21

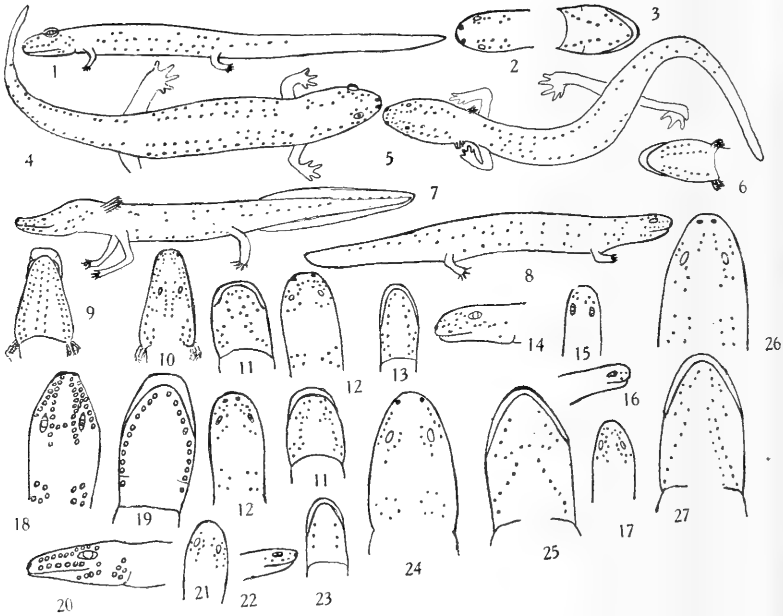

PLATE 22

AUSTRALIAN TINGIDÆ (Hemiptera)

By CARL J. DRAKE
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Since the publication in 1925 of "RESULTS OF DR. E. MJOBERG'S SWEDISH SCIENTIFIC EXPEDITIONS TO AUSTRALIA 1910-1913," Horváth, ARKIV FOR ZOOLOGI, considerable interest has been taken in the Tingidæ of Australia. Most of the papers on these Australian insects have been published by Hacker and by Drake and coworkers.

The present paper contains the descriptions of ten species and notes on a few other species. Illustrations of two species described by Horváth are also included. The writer is indebted to the officials of the Stockholm Museum for the privilege of studying type specimens of certain species described by the late Doctor Horváth. The types of the new species described below are in the Drake collection, and are largely from the H. H. Hacker collection of Australian Hemiptera.

NATHERSEA MACULOSA Horváth

Nethesia maculosa Horváth, Ark. Zool., 17 (24) : 15, 1925, fig. 9.

Type, female, Broome, in Stockholm Museum. Head ferrugineous, pitted, with four short testaceous spines; hind pair appressed, extending forward as far as middle of eyes, front pair shorter, with tips directed inward. Eyes large, black. Rostral channel very wide, open behind; laminæ rather wide, testaceous, uniseriate, clothed with bristly hairs; rostrum not reaching middle of mesosternum. Hypocostal ridge uniseriate, the areolæ small. Pronotum strongly convex, shiny, the pits moderately large; lateral carinæ almost obsolete on disc, distinct on hind process, there testaceous; paranota narrow, keel-like behind, wider and uniseriate in front, there reflexed upward and testaceous; collar distinct, scarcely raised, areolate.

The above notes were taken from the type. It was difficult to trace the lateral carinæ on the disc, although visible with good light. In front the carinæ are distinct and whitish.

Male: Longer and slenderer than female; lateral carinæ distinct on disc, there (as in female) concolorous with pronotal disc. Antennæ and legs clothed with stiff, bristly hairs.

PARACOPIUM SUMMETVILLEI (Hacker)

Teleonemia summervillei Hacker, Mem. Queens. Mus., 9 (1); 22, 1927, Pl . IV, fig. 4.

Described from Palm Island, N. Q.; two paratypes studies. Breeds on *Scoevola Koenigii* Vahl. Other specimens examined: 4 from Dunk Island, Aug. 27, 1927; 3 from Bowen, Queensland, June 21, 1930; 2 from Prince Wales Island, Torres, St. Austr.; and one from New Hebrides, March 15, 1943, collected by P. W. Oman.

LEPTOYPHA ANCEPS (Horváth)

Paracopium anceps Horvàth, Ark. Zool., 17 (24) : 9, 1925,

The type (male), Yarrabah, and two males, Dunk Island, Aug. 1927, have been examined. The third segment of the antennæ is smooth, slenderest and slightly more than twice as long as IV. The pronotum is coarsely pitted as in *L. hospita* Drake and Poor from the Philippines and *L. suppura* Drake from Japan.

Tingis impensa, n. sp., Plate 24, fig. a

Large, obovate, dark brown. Head tumid above, dark ferrugineous, with five stout, dark ferrugineous spines, the median and hind pair of spines directed upward, the front pair shorter, rather long, with their tips touching. Rostrum long, extending on venter; laminæ parallel, not widely separated, open behind. Thorax beneath brown, the venter yellowish. Antennæ ferrugineous-brown; segment I short, much stouter and twice as long as II; III broken off some distance from base. Eyes rather large, red. Legs brown. Orifice present. Hypocostal ridge uniseriate.

Pronotum sharply, transversely convex, coarsely pitted, tricarinate; median carinæ uniseriate, sharply angulately raised on disc, there biseriate and with a narrow, transverse, areolate laminæ; lateral carinæ long, concave within and slightly more widely separated anteriorly. Collar raised areolate; without distinct hood; paranota rather wide, strongly reflexed, widest opposite humeri, there four areolate deep and somewhat flaringly produced, triseriate in front. Elytra widest along basal half, completely overlapping in repose; costal area moderately wide, biseriate along basal third, thence uniseriate; subcostal area biseriate; discoidal area large, narrowed at base and apex, widest at middle, there about eight areolæ deep, the outer boundary sinuate.

PLATE 23

Tingis virigata Horvath

Length, 3.65 mm.; width, 1.40 mm.

Type, female, Tasmania, taken by Dr. J. W. Evans.

This species differs from all other members of the subgenus *Tingis* in the peculiar, transverse, areolate, plate-like structure of the median carinæ and the stout, erect median and hind pair of cephalic spines. The type is figured.

Tingis hurdæ, n. sp., Plate 25

Large, obovate, yellowish brown, the pronotum and a very broad transverse band on elytra darker reddish brown. Head short, brown, with five, stout, testaceous spines; median spine erect; hind pair appressed, extending a little beyond middle of eyes; front pair diverging laterally, somewhat curved upward; eyes large, reddish. Rostrum long, extending on metasternum; rostral laminæ parallel on mesosternum, widely separated and

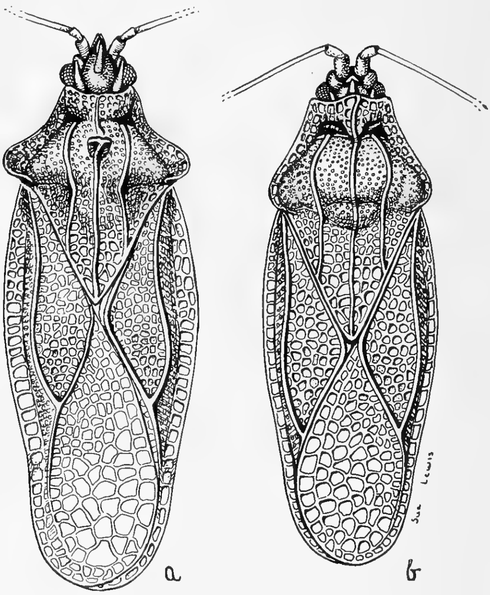

PLATE 24

a. Tingus impensa n. sp.;
b. *Tingis myobergi* Horvath

concave within on metasternum, widely open behind. Bucculæ rather long, broad, testaceous, meeting in front. Antennæ rather long, indistinctly pilose; segment I and II dark brown, short, the former much stouter and twice as long; III light brown, three times as long as IV; IV short, fusiform, mostly black. Abdomen beneath brown, the mesosternum black.

Pronotum longly convex, very coarsely pitted, tricarinate, each carinæ uniseriate, the areolæ tiny; lateral carinæ diverging anteriorly, broadly concave within in front; hood and collar testaceous, the hood small, inflated, tectiform, slightly protruding in front; carinæ testaceous, moderately broad, reflexed almost upright, mostly biseriate, uniseriate behind. Orifice present. Hypocostal ridge uniseriate. Elytra completely overlapping behind in repose; costal area wide, mostly biseriate, triseriate in widest part; subcostal area largely triseriate; discoidal area long, narrowed at base and apex, six areolæ deep in widest part. Legs yellow brown.

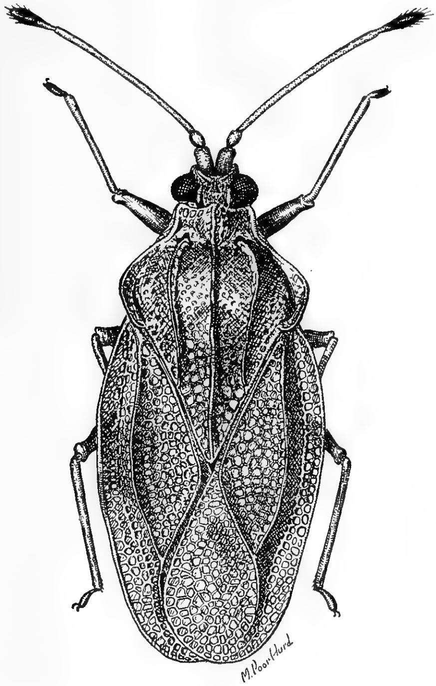

PLATE 25

Tingis hurdæ, n. sp.

Length, 4.25 mm.; width, 1.85 mm.

Type (male), Queensland, Australia, taken by H. Hacker. The type is figured.

This species (subgenus Tingis) is broader than other members of the subgenus Tingis; the high carinæ, spines and pale trum and wide paranota are distinguished characters. Named in honor of the artist, Dr. Margarat Poor Hurd, who has illustrated many Tingidæ and published numerous papers on the family.

Tingis aemula, n. sp.

Elongate-ovate, testaceous, the pronotum reddish brown; head brown, with five, long, slender, brownish spines, the surface of

head and spines beset with pale hairs. Antennæ long, slender, brown, clothed with pale, bristly hairs; segment I short, much stouter and less than twice as long as II; III very long, straight, much more than three times as long as IV, the latter subclavate. Eyes rather small, transverse, reddish. Bucculæ broad, closed in front, areolate, brownish testaceous. Rostrum extending a little beyond mesosternum; channel wide, the laminæ testaceous, not meeting behind. Legs brown, setose. Body beneath reddish brown.

Pronotum moderately, longly convex, coarsely pitted, tricarinate; carinæ strongly foliaceous, high, mostly uniseriate, the areolæ rectangular, upright; hood small, faintly projecting anteriorly, paranota subequal in width to height of carinæ, reflexed, biseriate, testaceous. Elytra, carinæ, paranota and collar clothed with pale, somewhat recumbent hairs, their margins and also principal nervures of elytra with pale, shorter, recurved bristly spines or hairs. Elytra with tips slightly separated in repose; costal area moderately wide, biseriate, the areolæ clear; subcostal area biseriate; discoidal area long, extending beyond middle of elytra, narrowed at both ends, widest at middle, there four areolæ deep, the boundary nervures raised and spinose.

Length, 3.00 mm.; width, 1.20 mm.

Type, female, Oldea, South Australia, collected by A. M. Lea.

This species may be separated from other Australian members of the subgenus Tingis by the high carinæ, spines and pale hairs on veins.

Tingis muiri, n. sp.

Moderately large, brownish. Head black, with short, testaceous spines. Antennæ brown, nearly as long as pronotum, indistinctly pilose; segment I short, stouter and nearly twice as long as III; III a little more than twice as long as IV, the latter mostly black and pilose. Rostrum long, nearly reaching end of channel; laminæ testaceous, areolate. Hypocostal ridge uniseriate. Orifice present.

Pronotum moderately convex, pitted, distinctly tricarinate, the carinæ slightly lower on disc, the lateral pair concave within in front of disc; collar truncate in front, narrow, raised, biseriate; hood absent; calli dark, deep; paranota narrow, reflexed upward, uniseriate, narrower opposite humeri. Elytra slightly narrowed posteriorly, constricted behind middle; costal area narrow, mostly uniseriate, biseriate in front, the areolæ very small; subcostal area

wider, biseriate, discoidal area large, about two-thirds as long as elytra, widest near middle, there seven or eight areolæ deep; sutural area large, more widely areolate.

Length, 3.45 mm.; width, 1.15 mm.

Type (male), allotype (female) and 3 paratypes, Coolangata, Queensland, Aug. 1919, taken by Muir.

This insect may be distinguished from the members of the subgenus *Tropidocheila* by the low carinæ, narrow paranota and nearly uniform color of reticulations.

Tingis acris, n. sp.

Small, grayish testaceous, with dark fuscous markings. Head dark castaneous, with five testaceous spines, the median short, sometimes wanting; hind pair longest, appressed. Antennæ moderately long, indistinctly pilose, testaceous, the terminal segment blackish; segment I short, stouter and slightly longer than II; III longest, two and one-half times the length of IV. Rostrum extending to middle of mesosternum; laminæ foliaceous, areolate, not meeting behind. Bucculæ broad, contiguous in front. Body beneath brown. Orifice prominent. Hypocostal ridge narrow, uniseriate.

Pronotum transversely convex, pitted, sharply tricarinate; carinæ uniseriate, the areolæ indistinct in front, the lateral carinæ more widely separated and concave within in front; paranota reflexed upward, biseriate; collar raised, truncate in front, with small hood. Elytra with wide, transverse band near middle of costal and subcostal areas, most of discoidal and sutural areas dark fuscous; costal area narrow, uniseriate; discoidal area large, extending beyond middle of elytra, widest near middle, there seven or eight areolæ deep. Carinæ on disc dark fuscous.

Length, 2.20 mm.; width, 0.90 mm.

Type (male), allotype (female) and 2 paratypes, Benakin, Queensland, March 17, 1933, H. Hacker. This is species belonging to the subgenus *Tropidocheila* and is smaller than other species described herein.

Tingis perkensi, n. sp.

Moderately large, grayish testaceous, variegated with brown to fuscous. Head brown, with five short, sharp spines, the hind pair appressed, the median short, erect. Eyes transverse, reddish. Rostral channel narrow, open behind, the laminæ testaceous; ros-

trum brownish, reaching middle of metasternum. Bucculæ testaceous.

Orifice prominently rimmed. Hypocostal ridge uniseriate. Legs testaceous, the tarsi dark. Antennæ moderately long, testaceous, indistinctly pilose; segment I short, stout, scarcely longer than II; III, about two and one-half times the length of IV; IV thickened, blackish.

Pronotum transveresly convex, coarsely pitted, tricarinate; lateral carinæ sharply raised, non-areolate, slightly diverging anteriorly, slightly convex within before disc; median carinæ slightly more elevated, indistinctly areolate; hood rather small, areolate, roundly produced in front, somewhat flattened above; paranota narrow, reflexed, biseriate. Elytra constricted beyond middle, completely overlapping behind; costal area moderately wide, biseriate; subcostal area biseriate; discoidal area impressed, narrowed at base and apex, closely areolate, widest near middle, there seven or eight areolate deep; sutural area large, more widely reticulate.

Length, 3.00 mm.; width, 0.95 mm.

Type (male), allotype (female) National Park, Queensland, May, 1929. Paratypes, many specimens, taken with type and from Mt. Glorious, Queensland.

The smaller size and biseriate costal area separate this species from other members of the subgenus *Tingis* occurring in Australia.

Tingis hackeri, n. sp.

Head brownish, black, the frontal spines short, the hind pair slender, appressed. Rostrum extending beyond mesosternum; laminæ foliaceous, areolate, testaceous, not meeting behind. Antennæ moderately long, pilose, testaceous, the terminal segment blackish; segment I short, stout, stouter and slightly longer than II; III longest, two and one-half times the length of IV. Rostrum extending beyond middle of metasternum; laminæ foliaceous, areolate, not meeting behind. Bucculæ broad, contiguous in front. Body beneath brown. Orifice prominent, with an elongate hypocostal ridge.

Pronotum transversely convex, brown on disc; carinæ prominent indistinctly areolate, the lateral distinctly constricted behind disc, longly concave within in front; hood moderately large, scarcely produced in front; paranota narrow, reflected, biseriate. Elytra and paranota clothed with fine rather short hairs; costal

area moderately wide, biseriate; subcostal area narrower, biseriate; discoidal area large, narrow at base and apex, widest at middle, there seven areolæ deep; sutural area more wide areolate. Reticulations yellowish brown to brown, variegated with dark fuscous.

Length, 4.00 mm.; width, 1.60 mm.

Type (male) and allotype (female), National Park, Queensland, December, 1921, H. H. Hacker. Allotype, Mt. Tambourine, Queensland, H. H. Hacker. Four paratypes, taken with types; 1 specimen from Springbrook, Dec. 29 and 1 example, Mackag, Kuttabal, June 10, 1932, W. A. McDougall.

This subpilose species (subgenus *Tingis*) is distinctly larger than *T. perkinsi,* but of same general appearance.

Tingis teretis, n. sp.

Small, clothed with short, pale scale-like hairs. Head black, clothed with short, pale, flattened hairs, the front and hind pairs of spines brown, short, the median absent. Antennæ moderately long, clothed with pale, moderately long, somewhat decumbent hairs, segment I very short, thicker and scarcely longer than II, the latter moniliform; III very long, nearly three times as long as IV, IV subclavate, short, black. Rostrum long, reaching on metasternum, the laminæ not widely separated, parallel. Legs ferrugineous, rather short, clothed with whitish, flattened, somewhat decumbent hairs, the tarsi blackish.

Pronotum dark reddish brown, deeply closely pitted, clothed with white, recumbent, scale-like hairs, tricarinate, truncate in front; carinæ low, minutely uniseriate, the outer pair slightly concave within in front; paranota narrow, brown, with minute areolæ in front; collar raised, brown, areolate.

Elytra a little longer than abdomen, moderately constricted beyond the middle, completed overlapping behind in repose; costal area narrow, uniseriate, finely serrate along outer margin, the areolæ small, longer than wide, subcostal area much wider, quadriseriate; discoidal area large, about three-fourths as long as elytra, narrowed at both ends, widest at middle, there six or seven areolæ deep, the outer boundary nearly straight; sutural area large, the areolæ largely apically.

Length, 2.20 mm.; width, 0.90 mm.

Type, male, Ooldea, South Australia, collected by A. M. Lee.

This species, perhaps, belongs to the subgenus *Tingis,* and may be separated at once by the clothing of pale scale-like hairs.

Froggottia disticha, n. sp.

Large, brown, without conspicuous color markings. Head rugulose; hind pair of spines absent, the anterior ones greatly reduced, appressed; eyes large, dark, transverse. Antennæ moderately stout, yellowish, indistinctly pilose; segment I short, slightly stouter and a little longer than II, the latter obconical; III straight, two and a half times as long as IV; IV slightly thickened, mostly fuscous black. Bucculæ brown, contiguous in front. Rostrum extending to middle of mesosternum. Hypocostal ridge uniseriate. Legs yellowish brown.

Pronotum moderately convex, coarsely pitted, unicarinate, the lateral carinæ indistinct; paranota very narrow, ridgelike; collar raised, short, areolate. Elytra distinctly constricted before apex; costal area narrow, biseriate in front, uniseriate behind, the areolæ small, round; subcostal area wider, biseriate; discoidal area large, extending to middle of elytra, widest a little behind middle, there five areolæ deep; sutural area large, more widely reticulate.

Length, 3.65 mm.; width, 1.25 mm.

Holotype, female, Cedar Creek, Queensland, Australia, Jan. 25, 1921.

Separated from the olive bug *F. olivina* Horv. by its uniform color, narrower paranota, spines on head and paranotal carinæ.

Teratocheila accedentis, n. sp.

Moderately large, brown, with dark fuscous markings, the areolæ hyaline, the margin of elytra and nervures of paranota, carinæ and hood hairy. Head black, with five, moderately large, yellowish brown, hairy spines. Antennæ moderately long, shortly pilose; segments I and II short, stout; III slender, long, four times as long as IV, the latter subclavate, blackish. Rostrum brownish, very long, extending on third or fourth venter. Legs dark brown, shortly hairy. Orifice with distinct rim. Hypocostal ridge uniseriate. Bucculæ long, narrow, areolate, testaceous.

Pronotum broadly transversely convex, coarsely pitted; carinæ foliaceous, uniseriate; median distinctly arched on disc; lateral carinæ becoming higher anteriorly, moderately constricted on disc; paranota wide, evenly rounded, triseriate in widest part. Elytra wide; costal area broad, irregularly triseriate, the areolæ moderately large; subcostal area biseriate; discoidal area very large, more finely reticulate, widest a little behind middle, there eight areolæ deep, sutural area large, becoming more widely areolate behind.

Length, 4.10 mm.; width, 2.00 mm.

Type (female), paratype, Aldgate, Australia, October. 1929, F. E. Wilson.

This is the first record of this genus in Australia. It is larger and the lateral carinæ extend a little farther forward than in *T. peurilis* Drake & Poor from India. *Pyllontocheila cafer* Distant from Africa seems to belong to *Teratocheila.*

Physatocheila suttoni, n. n.

Physatocheila irregularis Hacker, Mem. Queens. Mus., 9:328, 1929, Pl. XXXIII, fig. 6.

As the specific name of *P. irregularis* Hacker is preoccupied—*Physatocheila irregularis* Montrouziei et Signoret, ANN. SOC. ENT. FR., 1861, p. 68—the name *suttoni* is proposed for Hacker's species. Several specimens of this species were collected bv E. Sutton in Queensland.

PARALEUCOPTERA HEINRICHI n. sp.

By Wyatt W. Jones

Similar to *P. albella* (Chamb.) but differing in the much narrower golden fascia, much more inclined, and with sharper margins of blackish-fuscous scales; in the prominent median dark band of the cilia, usually accompanied with an apical band and one about the base of the cilia; in the oblique V formed by fascia and a dark line bordering the yellow patch more towards apex instead of a normal V, and in the interruption of the yellow scales above the semi-metallic tornal spot. The caudal margin of the seventh sternite is fringed by concealed black hairs.

The striking differences in the genitalia are grought out in the illustrations by Mrs. Sara H. DeBord of the U. S. Bureau of Entomology which were kindly furnished by Mr. Carl Heinrich. See Plate 26.

Holotype: ♂ Palo Alto, Calif., emerged April 9, 1946.

Allotype: ♀ Palo Alto, Calif., emerged April 10, 1946, coll. J. W. Tilden.

5 paratypes, Palo Alto, Calif., emerged April, 1928, coll. W. W. Jones.

1 paratype, Palo Alto, Calif., April 9, 1946, J. W. Tilden.

16 paratypes, Palo Alto, Calif., emerged April, 1946, coll. J. W. Tilden.

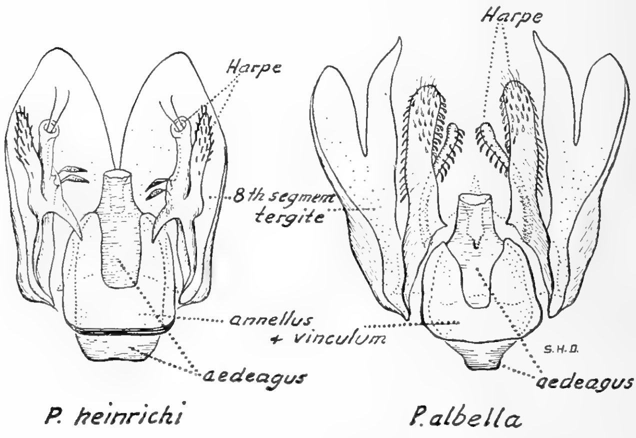

PLATE 26

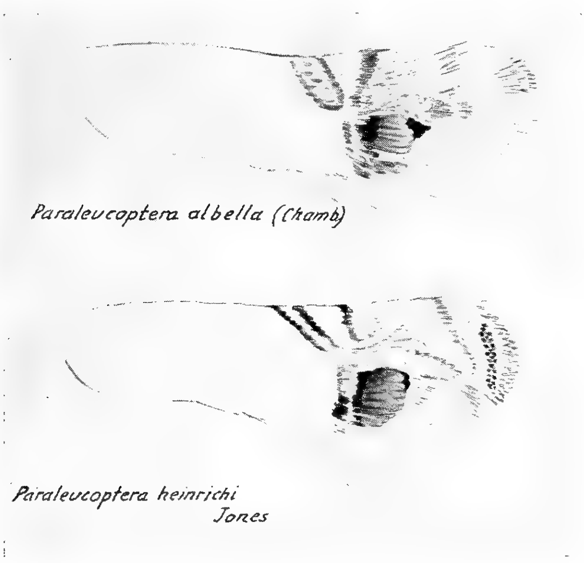

PLATE 27

32 paratypes, Los Angeles, Calif., emerged April, 1946, coll. W. W. Jones.

1 paratype, Palo Alto, no date, coll. W. W. Jones, on "Prunus ilicifolia."

Specimens have been distributed as follows: 2 to the U. S. National Museum; 11 to Mr. J. W. Tilden of Stanford University, who sent us mined leaves and his own specimens for study. Holotype, allotype and 55 paratypes at present deposited in the Los Angeles Muesum.

In the winter the mines are merely brownish spots on the host leaves resembling fungous infections. The presence of larvæ can be detected by examination in strong transmitted light and with a lens. Four larvæ are practically always found in one mine. No adults have been seen out of doors.

Mines are abundant at Palo Alto and Los Angeles but have not been observed at Berkeley nor San Diego.

Plate 27 illustrates the right primaries of *Paraleucoptera heinrichi* and *P. albella* (Chamb.)

Foodplant; *Prunus ilicifolia* Walp. and *Prunus Lyonii* (Eastw.) Sarg.

NOTES ON THE LIFE HISTORY OF ORTHODES ACCURATA

HY. EDWARDS

By JOHN ADAMS COMSTOCK

This species was first described in 1882 by Henry Edwards [1] as *Plusia accurata,* from a single female collected in Arizona by H. K. Morrison, with the type recorded as in the Neumoegen collection.

John B. Smith listed it under *Plusia* in his Catalogue of the Noctuidæ,[2] giving the habitat as "Washington," and stating that "it is probably not a Plusia at all."

Dyar in his List of North American Lepidoptera[3] placed it in the genus *Autographa* and follows Smith in recording it as occurring in Washington.

Hampson[4] gave its range as "Washington, Arizona, Huachuca Mts. (Oslar)," and placed it in the genus *Cobaliodes.*

The Barnes and McDunnough List of 1917[5] followed Hampson, leaving it in *Cobaliodes,* but McDunnough, in his Check List of 1938[6] transferred it to *Orthodes.*

In the Los Angeles County Museum collection we have examples from Brewster County, Texas; Paradise, Arizona; Baboquivaria Mountains, Arizona and a reared series from Madera Canyon, Santa Rita Mountains, Arizona, but none from California, Oregon or Washington. Apparently Smith was in error when he gave its habitat as Washington.

During August of 1946 the writer spent two weeks collecting in and below Madera Canyon, Santa Rita Mountains, southern Arizona.

Among the lepidopterous larvæ that were taken was a series found on a species of *Brickellia* (probably *Rusbyi* Gray), several of which were reared to maturity and proved to be *Orthodes accurata* Hy. Edw.

The larva folds a leaf, uniting the edges with a fragile silk and remains concealed during the daytime.

MATURE LARVA: average length, 26 mm.

Head; glistening dark orange. Ocelli tipped with brown. Mouthparts concolorous with head.

Body; ground color, rich velvety black. The first segment bears a glistening black scutellum.

On the first three segments there is a mid-dorsal broken line composed of white dots and dashes. Lateral to this are two or

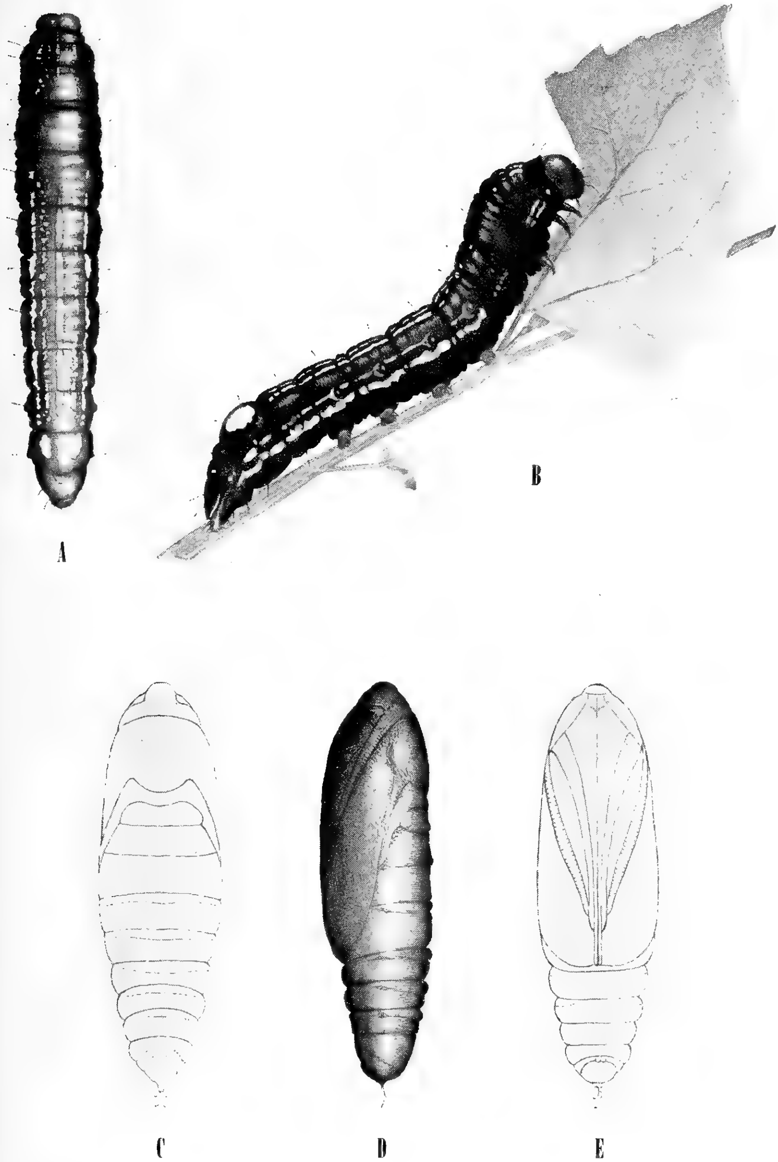

PLATE 28

Mature larva (figures A and B) and pupa (figures C, D and E) of Orthodes accurata Hy. Edw,
Larva enlarged approximately X $2\frac{1}{2}$. Pupa enlarged X 3.

Reproduced from painting by John A. Comstock

three fine longitudinal lines made up of white dots, irregularly placed and variable as to size, number and position in different individuals.

Along the infrastigmatal fold occurs another double white line composed of dots or dashes. This is occasionally suppressed along part of its course.

On the 4th and fifth segments the dorsal area is almost devoid of spots, giving the appearance of a velvety black saddle. Occasionally the 5th segment has a few irregular white spots. Dorsolaterally in this area a small number of irregular white dots are present.

From the 6th to the 10th segments there is a wide longitudinal mid-dorsal orange band, margined with black. Lateral to this is a double line composed of white dashes of irregular form and size.

Infrastigmatally there is a longitudinal line made up of mixed orange and white elements, and above this, in line with the spiracles, occurs a line made up of small white dashes. Caudal to each spiracle this line expands to form a lunate mark which arches around the margin of the spiracle posteriorly. This lunate element is tinged with orange. The spiracles are white, and conspicuous.

The 11th segment bears two large white ovate spots, one each side of the mid-dorsal line.

Abdominal surface slaty gray. Legs, dark orange, as are also the prolegs. Crochets, straw colored. The infrequent setæ are straw colored, short and inconspicuous.

Plate 28, figures A and B illustrate the mature larva.

Pupation occurs under the soil in a fine silken barely definable cocoon into which particles of gravel and soil are incorporated.

Thirteen of our larvæ pupated successfully, of which one emerged September 30, 1946, and eight appeared between the dates of June 4 and June 27, 1947.

PUPA: length, 17 mm.; fusiform, the caudal and cephalic ends both well rounded.

Color, dark wood-brown. Surface, finely rugose, and apparently lacking all setæ. The wing cases extend 2/3 the distance toward cauda and the antennæ do not reach to the wing margins.

Spiracles, small and inconspicuous. Cremasteric hooks, four in number, arising from a rugose papillus, recurved laterally, one pair only half as long as the other.

The pupa is illustrated on Plate 28, figures C, D and E.

[1]Papilio. II; (8) 127. 1882.
[2]Bulletin 44, U. S. Natl. Mus. 257. 1893,
[3]Bulletin 52, U. S. Natl. Mus. 202. 1902 (1903).
[4]Cat Lepid. Phalaenae Br. Mus. VII: 506. 1908.
[5]Check List Lepid. Boreal Am. 63. 1917.
[6]Memoirs So. Calif. Acad. Sci. I: 74. 1938.

ANALYSIS OF MEASUREMENTS IN LENGTH OF THE METAPODIALS OF SMILODON

By HENRY W. MENARD, JR.

Introduction.—The saber-tooth cats are perhaps the most interesting members of the Pleistocene fauna from Rancho La Brea. As a result of the study by Merriam and Stock[1] these machærodonts are known to be the most striking of the Felidæ occurring at this locality, both in abundance, and in the unusual morphological characters which they possess. Opportunity has been presented recently to make a statistical analysis, limited in scope, of measurement data relating to metapodials of these animals. This investigation appeared desirable not only because of the extraordinarily large number of individuals available from the asphalt deposits, but also because a similar analysis has been made recently of the extinct dire wolf material from the same locality by Nigra and Lance.[2]

Acknowledgments.—The large numbers of specimens in the Rancho La Brea collection were generously made available for study by the Los Angeles County Museum. The writer is indebted to Dr. Chester Stock for assistance and guidance, and likewise to John F. Lance for help in the progress of the computations.

Procedure.—Approximately 5000 metapodials of *Smilodon* were measured with regard to maximum length. Only those of the left side were used since it was found that the extent of variation and mean length of the elements on one side do not materially differ from those of the opposite side. In the manus metacarpals II, III, IV and V were measured, while in the pes only metatarsals II, III, and IV were employed for measurement data. Metatarsal V was not measured since it was found difficult to standardize the longitudinal diameter of an element with the variable curvature of this metapodial. Metacarpal I and metatarsal I were likewise not measured because too few of these elements are present in the collection.

For each metapodial, the measurements of length were analyzed to determine the arithmetic mean, standard deviation, and coefficient of variation. The maximum and minimum lengths of each element were also established. Furthermore, the metapodials were segregated according to the excavations from

[1]Merriam, John C. and C. Stock, Carnegie Inst. Wash. Contrib. No. 422, 1932.

[2]Nigra, John O. and John F. Lance, Bull. So. Calif. Acad. Sci., vol. 46, pt. 1, pp. 26-34, 3 pls., 1947.

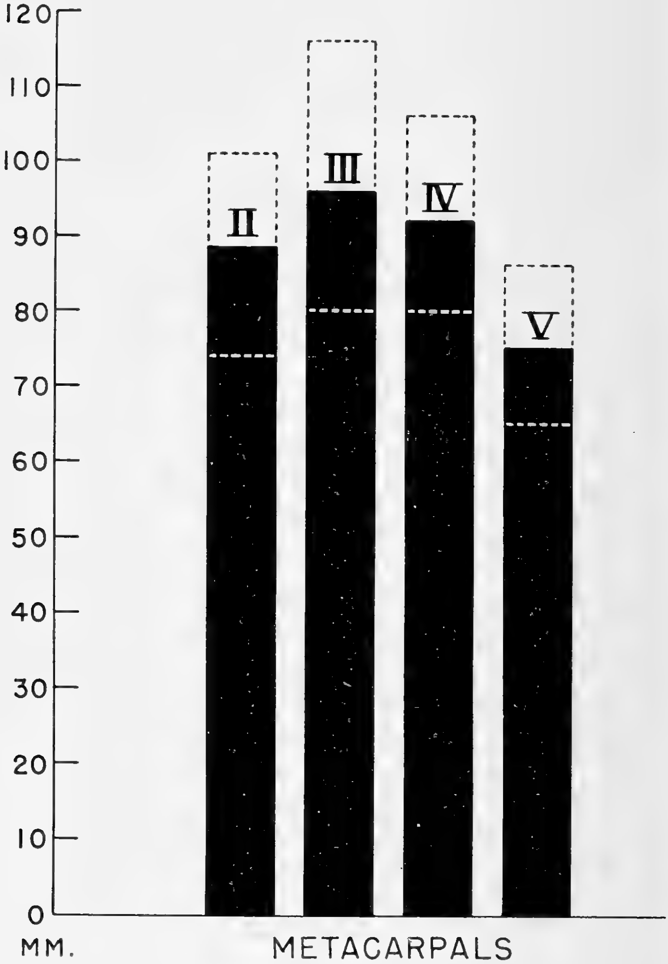

PLATE 29.—Actual and relative sizes of left metacarpals in *Smilodon californicus*. The solid bars represent the mean size in each series the dotted lines above and below represent the maximum and minimum records, respectively.

which they were recovered at Rancho La Brea. As a result, the mean length for each series of metapodials was established for each of the major pits selected. These results are presented in charts and in the form of frequency curves and bar-diagrams.

The possibility seems slight that metapodials other than those of *Smilodon* were included in the measuring operation, because of

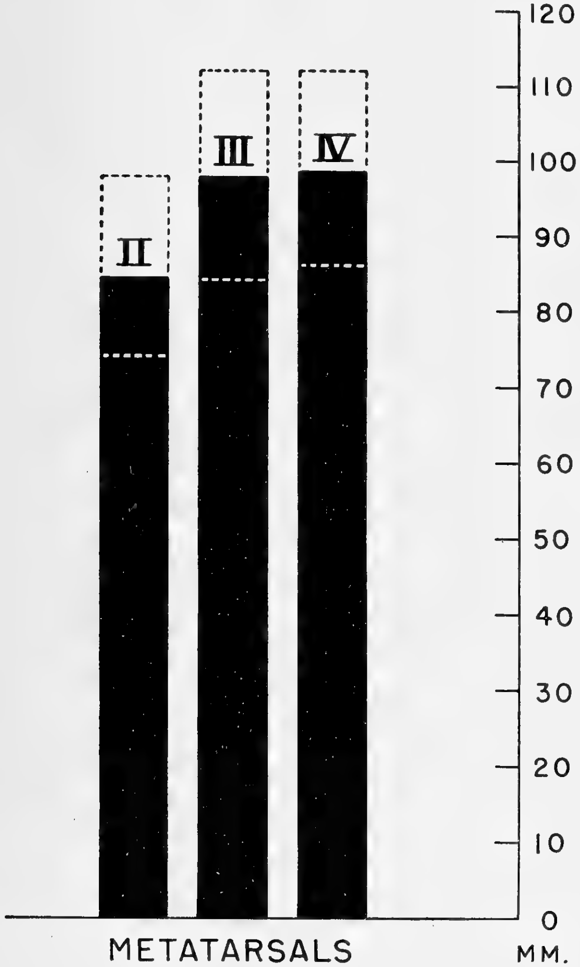

PLATE 30.—Actual and relative sizes of left metatarsals in *Smilodon californicus*. The solid bars represent the mean size in each series; the dotted lines above and below represent the maximum and minimum records, respectively.

the distinctive morphological characters readily recognized in these elements of the Pleistocene saber-tooth. On the other hand, the collection can not be regarded as pure for statistical purposes because both sexes are present. Also, some elements may not belong to wholly mature animals, although those belonging to obviously immature forms were not considered.

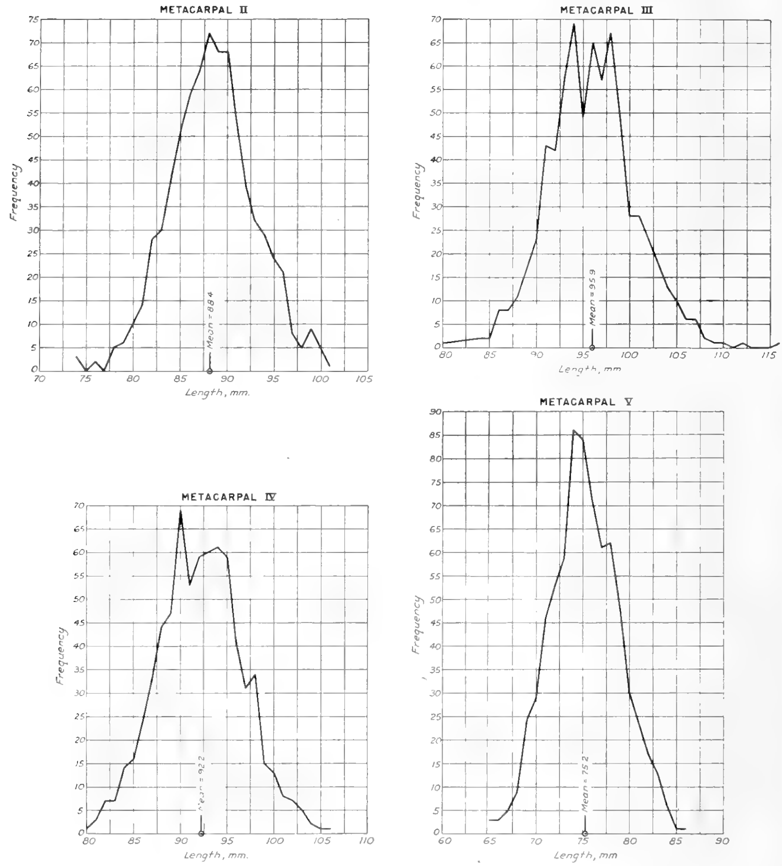

PLATE 31.—Frequency distribution curves of lengths of left metacarpals of *Smilodon californicus.*

Discussion of Statistical Results.—The maximum, minimum and mean lengths of the metapodials of *Smilodon* are graphically represented in Plates 29 and 30. These results agree substantially with those given by Merriam and stock.[3]

Graphs of the frequency distribution of metapodials of *Smilodon* according to length are shown in Plates 31 and 32. The lengths are grouped in class intervals which are ten times as coarse as the original measurements. The graphs appear normal except for minor variations. These may be attributed in part to differ-

[3]Merriam, John C. and C. Stock, *ibid.*, pp. 128-134, 153-158, 1932.

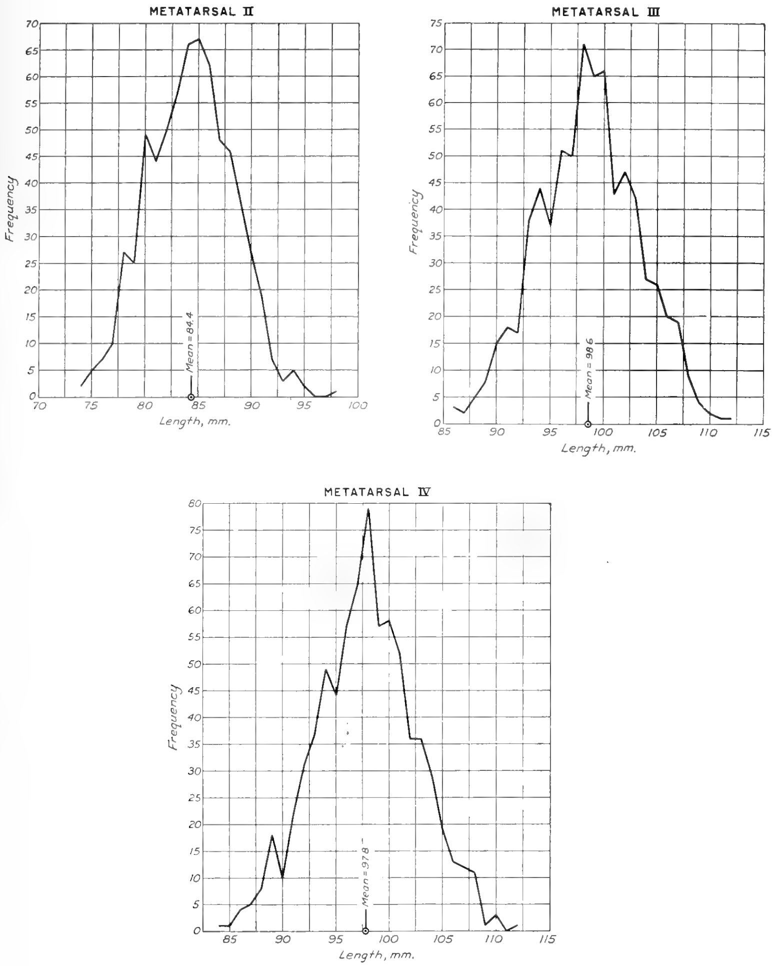

PLATE 32.—Frequency distribution curves of lengths of left metatarsals of *Smilodon californicus*.

ences in sex and age, and in part to the variation in size as determined for the material from the several excavations. Thus, each frequency distribution given actually represents the sum of a number of frequency distributions with slightly variable means.

The mean sample range for any sample of 700 individuals is approximately 6.275 times the standard deviation.[4] The observed

[4]Simpson, G. G., Range as a Zoological Character; Amer. Jour. Sci., vol. 239, pp. 785-804, 1941.

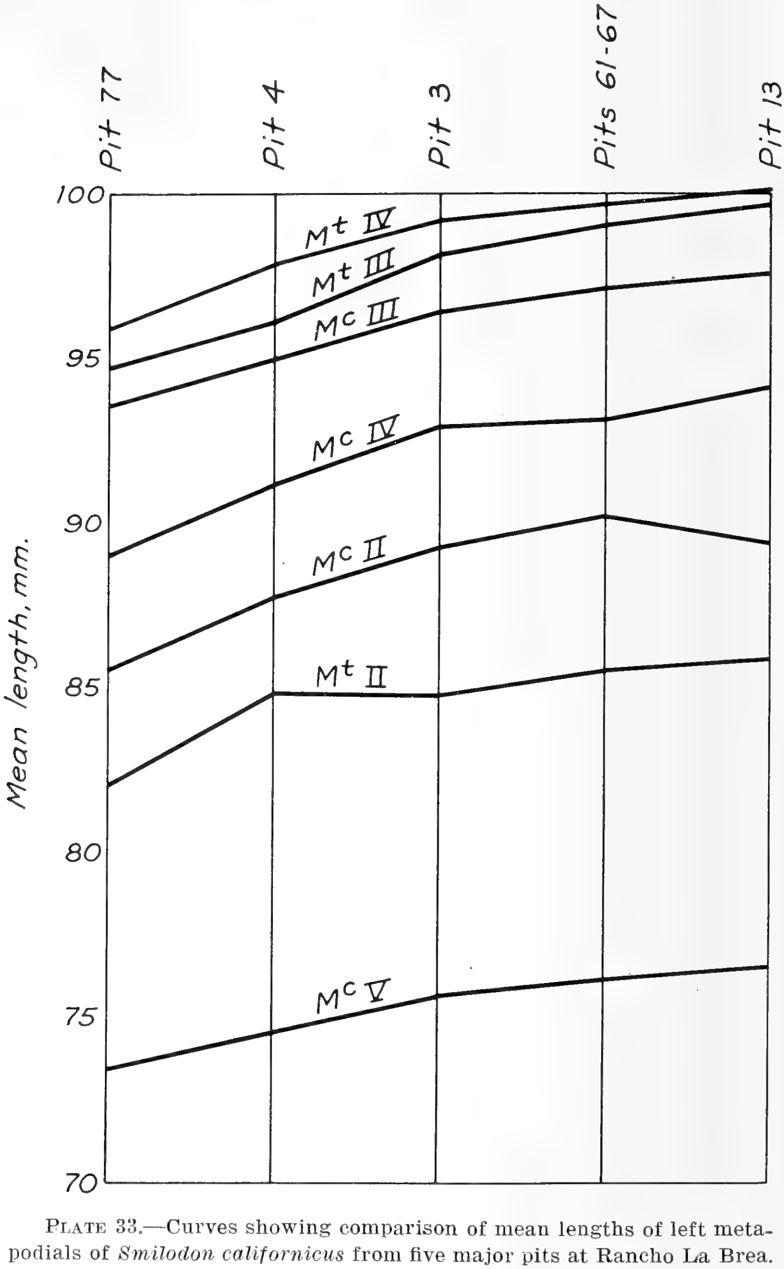

PLATE 33.—Curves showing comparison of mean lengths of left metapodials of *Smilodon californicus* from five major pits at Rancho La Brea.

ranges of metacarpals II, IV, and V, and of metatarsals II, III, and IV lie within the mean sample range for each metapodial. Metacarpal III has a mean sample range of 28.9 mm. and an observed range of 37 mm,, but, despite the large size of the observed range, only 0.28% of the sample lies outside the mean sample range. However, in this instance, the possibility exists that an element 80 mm. long represents the small subspecies occurring at Rancho La Brea, namely *Smilodon californicus brevipes.* This smallest third metacarpal is four millimeters shorter than the next shortest element in the series, and is therefore separated from it by a standard deviation of 87. For the series this is an unusual hiatus. The present metacarpal cannot be compared morphologically to *S. c. brevipes* because the corresponding element has not been described for that subspecies. However, Merriam and Stock[5] have observed that each metapodial of *brevipes* shows approximately the same degree of shortening when compared with the corresponding element of *Smilodon californicus* (ss.). If the shortest metacarpal III in the present series is considered to belong to *brevipes*, and is compared with the remaining third metacarpals the degree of shortening is found to be not of the same order of magnitude as that which would be expected for the small subspecies. The longest third metacarpal measures 116 mm. This specimen is four millimeters longer than the next longest element. The value of its standard deviation from the mean is 4.4. The metacarpal falls within the size range of *Panthera atrox,* but on the basis of its morphological characters it definitely belongs to *Smilodon.*

Since the frequency curve is more or less normal for each of the several kinds of metapodials measured, the observed range closely approximates the mean sample range, and the coefficient of variation is small. It appears also that the sample is pure and contains individuals of only one species.

Analysis of data differentiated according to individual Museum excavations.—The mean length of each series of metapodials was calculated for each of five major excavations at Rancho La Brea from which they were recovered. With two minor exceptions, the mean was found to vary from pit to pit according to a definite sequence. In the order of increased length, the metapodials come from Pits 77, 4, 3, 61-67, and 13. This relation is shown graphically in Plate 33.

It is worthy of note that a similar sequence was found in the mean length of metapodials of the *Canis* (*Aenocyon*) group from Rancho La Brea.[6] However, in the instance of the dire wolf group, the sequence of pits is not the same as that arrived at for

[5]Merriam, John C. and C. Stock, *ibid.*, p. 163, 1932.

[6]Nigra, John O. and John F. Lance, *ibid*, 1947.

the saber-tooth. With regard to Pits 4, 3, and 13, the order is reversed, since Pit 13 contained the longest elements. Pits 61-67 and 77 do not appear to fit into any discernible order if the mean length of metapodials of *Smilodon* and of the *Aenocyon* group are compared.

Calculations.—One of the procedures suggested by Simpson and Roe was used in making the calculations for this paper. The equations employed may be found in a recent paper in this Bulletin (Nigra and Lance).[7]

[7]Nigra, John O. and John F. Lance, *ibid*, 1947.

California Institute of Technology,
Division of the Geological Sciences,
Contribution No. 409.

MEAN, STANDARD DEVIATION, AND COEFFICIENT OF VARIATION OF LEFT METAPODIALS OF SMILODON

Metapodial	Number	Mean in Millimeters	Standard Deviation in Millimeters	Coefficient of Variation
MC II.....	747	88.4 ± .2	4.5 ± .1	5.1 ± .1
MC III....	708	95.9 ± .2	4.6 ± .1	4.8 ± .1
MC IV.....	715	92.2 ± .2	4.5 ± .1	4.8 ± .1
MC V.....	735	75.2 ± .1	3.7 ± .1	4.9 ± .1
MT II.....	666	84.4 ± .2	4.0 ± .1	4.7 ± .1
MT III....	759	97.8 ± .2	4.7 ± .1	4.8 ± .1
MT IV.....	731	98.6 ± .2	4.7 ± .1	4.7 ± .1

MAJOR PITS IN ORDER OF GREATEST YIELD

	PIT 3		PIT 61-67		PIT 77		PIT 4		PIT 13	
Metapodial	Mean length in mm.	No. of Spec.	Mean length in mm.	No. of Spec.	Mean length in mm.	No. of Spec.	Mean length in mm.	No. of Spec.	Mean length in mm.	No. of Spec.
MC II..........	89.2	261	90.2	171	85.4	144	87.7	77	89.3	40
MC III..........	96.4	237	97.1	177	93.5	138	94.9	64	97.6	44
MC IV..........	92.9	265	93.2	176	89.0	110	91.2	75	94.1	42
MC V..........	75.7	263	76.1	161	73.4	139	74.5	85	76.5	36
MT II..........	84.7	239	85.5	155	82.0	102	84.8	63	85.8	52
MT III..........	98.7	282	99.0	197	94.7	123	96.1	56	99.7	55
MT IV..........	99.2	255	99.7	198	95.8	112	97.8	62	100.1	50

FOSSIL ARTHROPODS OF CALIFORNIA

13. A PROGRESS REPORT ON THE RANCHO LA BREA ASPHALTUM STUDIES.

By W. DWIGHT PIERCE

I have been asked to prepare a progress report on the results so far obtained in the study of the insect life of the Pleistocene asphalt deposits at Rancho La Brea (Hancock Park), Los Angeles, California.

The material is so rich, and the problems of identification so complex, that it may be years before all of the results are presented. At the present time, however, certain points seem to be indicated, and perhaps the statement of these may assist those investigating other aspects of the material.

To date there have been found insect remains from 19 different pits (A, B, 3, 4, 9, 10, 13, 16, 28, 29, 36, 37, 51, 60, 61, 67, 77, 81, 101) at Rancho La Brea and some from a site on Wilshire Boulevard several blocks beyond Hancock Park.

Since matrix material for original examination was only available from pits A, 81, and 101, George Kanakoff, of the Division of Life Sciences, suggested study of the skulls of the saber-tooth cat, *Smilodon californicus,* an undoubted Pleistocene animal. Most of the skulls had only been superficially washed in kerosene, so they were soaked in benzene, and the contents of the brain cavity syringed out. This proved a valuable source for fine material, and the data on the skulls gives very significant information. In all, 27 skulls have been washed out, coming from pits 3, 4, 13, 60, 61, 67, 77. The horizontal and vertical positions where each skull was found make the information exact. The depths at which these were found range from 4 feet to 19.5 feet below the surface.

Many species of tiny insects were recovered from the skulls, which had not been obtained in the washing and sifting from Pits A, 81, and 101. When the whole story is told, most of the species records will come from more than one pit.

By far the greatest bulk of the chitinous material consists of beetle remains, with millipede (Julidae) next in quantity. As a criterion, the number of beetle elytra so far recovered is 2867, some from each of the pits listed, although 1899 are from Pit A, 166 from Pit 81, and 155 from Pit 101, which we have only begun to examine.

So far there have been located 14 families of beetles, which may be ecologically separated as: water beetles (Dytiscidæ, Hydrophilidæ, and Haliplidæ); carrion beetles (Silphidæ, Dermestidæ, Histeridæ); predaceous beetles (Carabidæ, Cicindelidæ); dung beetles (Scarabaeidæ); ground dwelling beetles (Tenebrionidæ); and plant feeding beetles (Cerambycidæ, and weevils of the families Platypodidæ, Apionidæ, Psallidiidæ, and Curculionidæ).

Pit A has also yielded Orthoptera, Araneida, Diptera, Diplopoda, and Hymenoptera (wasp and ant); Pit 3 gave Diptera Hemiptera, Diplopoda, Isoptera (termite droppings), and insect galls; Pit 13 termite droppings, Hemiptera, and Homoptera; Pit 67 Ostracoda shells, Diptera, and Hemiptera; Pit 81 Diptera, Hymenoptera, and Diplopoda; and Pit 101 has already yielded Orthoptera, Isoptera droppings, Diplopoda, Hymenoptera (ants), Hemiptera, and Phalangida.

Little has been done toward determining the non-Coleopterous material, but we may list among the Orthoptera, Jerusalem crickets (Genus Stenopelmatus, Gryllacrididæ), and grasshoppers (Acrididæ). The Diptera are largely puparia of Metopiidæ (blow flies and fleshflies). The Hymenoptera are Vespidæ, and Formicidæ (ants). The Hemiptera are Notonectidæ (backswimmers), and Corixidæ (water boatmen).

The turmoil in the tar has resulted in complete separation of the parts of the skeleton of most insects; only rarely are several parts connected. The eye sockets are empty, and mouthparts gone in all La Brea material.

Two conclusions seem permissible at present:

1. That the submergence of carcasses was very slow, permitting the disintegrating work of series after series of insects; first the blowflies and fleshflies, which attack in a few hours after death; second, the Dermestid beetles, of the genus *Dermestes;* third, the Silphid beetles, which belong to the genera *Nicrophorus* and *Silpha;* fourth, the Histerid beetles of the genus *Saprinus,* and other undetermined genera. This means that the carcasses reached the fourth and fifth stages of decomposition before complete submergence in the tar, which may mean up to 5 months exposure. It must have been a foul smelling locality.

2. There was probably standing water over a considerable period of the year, over the surface of the asphalt, because the predominant insect remains are water insects: Hydrophilidæ, Dytiscidæ, Haliplidæ, among the beetles; and Notonectidæ, and Corixidæ among the bugs. Likewise the presence of Ostracoda indicates that the water pools were more or less permanent.

Detailed studies of each group will follow as they are completed. This work has many difficulties, because there is no published comparative morphology of insects, and it sometimes takes a great deal of research to find where a fragment belongs in the classification scheme. The findings at McKittrick of whole insects will give many valuable clues for the La Brea study.

14. A PROGRESS REPORT ON THE McKITTRICK ASPHALT FIELD

By W. Dwight Pierce

In October 1945, the writer visited the asphalt field about a half mile south of McKittrick in Kern County, but at an altitude of 1250 feet, about 200 feet higher than the town. A new road had been cut directly through the tar field, and along this cut on the east side, there was a place where the asphalt had been recently cleft and started to sink. At a depth of about two feet below the crust a deposit of insects was found that was of great interest. This site was designated Site 3 McKittrick, the two University of California pits at the lower end of the same field on the west side being Sites 1 and 2.

On August 10, 1947, Mr. Leonard Bessom of the Paleontology Department of the Los Angeles County Museum visited the same road cut, and at a depth of about 4 feet found layers of insects of an entirely different series, the 1945 insects being all Coleoptera; the 1947 series being to a large degre Odonata, and Hemiptera, with many Coleoptera, and a mixture of other orders. There being at the time no way of correlating the two lots, Bessom's location was called Site 4.

The preliminary examination of Bessom's material brought out so much of interest and also raised so many questions, that "Operation McKittrick" was organized and carried out November 2, 1947, with George P. Kanakoff, Gearhard Bakker, Leonard Bessom, Robert Arris, Mrs. Cora Dahle, Mrs. Clara Pierce and the writer participating. The entire study was made on the Eastern exposure along the roadside.

Sites 3 and 4 were found to be just 5 feet apart. The Pierce 1945 material would correspond to the 24 to 30 inch layer at Bessom's Site 4. This 3-4 zone was 180 yards north of the beginning of asphalt exposures, the first evidences being oil sands deep under many feet of rock.

With measuring tape, zones for examination were marked off from Site 4 as base; Site 5 being 50 ft., Site 6 100 ft., Site 7

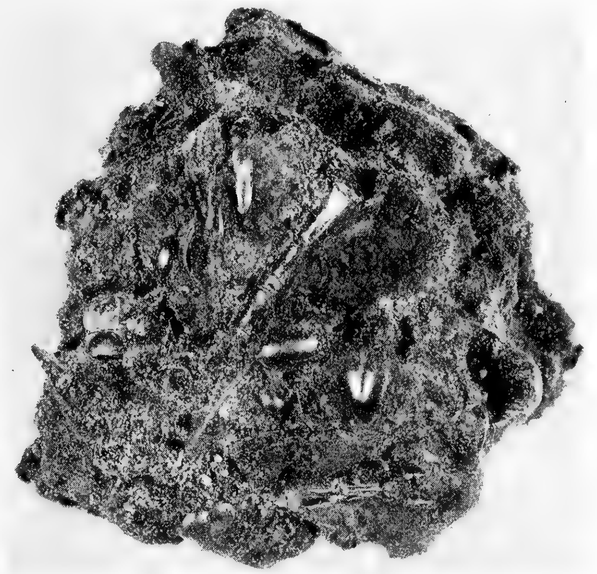

PLATE 34

A clump of matrix asphalt from McKittrick asphalt field, Site 4, depth 4 ft., showing in center Hemipterous wing, dragon fly bodies and beetles, at left dragon fly head, at right large beetle head.

150 ft., Site 8 200 ft., Site 9 250 ft., and Site 10 300 ft. south of Site 4. The diagonal height of the 45° slopes was: Site 4 12 ft., Site 5 16 ft., Site 6 18 ft., Site 7 44 ft., Site 8 32 ft., Site 9 40 ft., Site 10 55 ft.

The asphalt lies in definite strata which have about a 2° slope, although some levels are irregular. The top layer of very black asphalt at Sites 3, 4 was 28 inches thick, and it began at the surface near Site 5. Below this was a brown tar-filled zone of considerable depth, which at all exposures was rich in insect material. Below this was a blacker zone down to 100 inches at Site 4, 60 inches at Site 5, 48 inches at Site 6, and at the surface of Site 7. Sites 8, 9, and 10 showed only oil sands of even texture, probably not surface exposed; at Site 9 there was a recent flow over the matrix.

Samples were taken at every 6 inches vertical depth at Site 4; at every foot depth at Site 5; and a few samples at Sites 6, 7, and 10. Then 33 feet south of Site 4 a cleavage indicated good material, so this was called Site 11, and a sample taken in the same level as the 30 inch at Site 4.

PLATE 35

Enlargement from Plate 34 showing dragon fly head, and grasshopper leg.

Test holes have been dug by others in various places in the same field and in one of these were found insect deposits in the same stratum as the most productive 30 inch depth at Site 4.

Beyond the tar field to the east is a deep ravine into which a new flow of tar has been seeping. Here is the modern event happening, which must duplicate all of the events of long ago written in the asphalt deposits. In this shallow flow over the sand have been caught many dragon flies, beetles, a scorpion, a tenebrionid beetle, a Hydrophilid beetle, rabbit and crow, kangaroo rat, 3 snakes, and various small birds. Less than a half inch of tar lying over the tar-soaked sand has caught them and brought about their death. It had flowed during the summer, but had stopped by November 2. All animals were skeletonized by insects, but encrusted by dust, and on touching would crumble. The bones were white. It will take the flows of succeeding years to enclose and preserve the parts that are not destroyed by winds, and the many exigencies of nature. The animals seen by us were there in August at Bessom's first visit.

Then some distance to the West on a hillside draining into a wash filled with powdery alkali, this same thing was duplicated. In the shallow trickle of tar were caught Jerusalem cricket, dragon flies, beetles, rabbits, birds, and snake. All animals were encrusted and skeletonized.

John R. Schultz (1938) in an article "A late quaternary mammal fauna from the tar seeps of McKittrick, California" (Carnegie Inst., Washington, Publ. 487 (IV):115-215), discusses this field, from which may be quoted a few pertinent sentences: "From the existing distribution of the seeps, it seems probable that none of the fissures is very extensive laterally, and that the almost continuous belt of brea is actually due to coalescence of numerous individual seeps of slightly different ages rather than to one large flow. V. L. Vander Hoof——— has observed that old seeps become active after an unknown period of quiescence. It seems reasonable to assume that such was also the case from the earliest inception of the fissures, so that the brea belt rather than constituting one definite horizon actually may represent a complicated sequence of events extending from middle to late Pleistocene time down to the present.

"During late Pleistocene sedimentation was active in the area and as the oil reached the surface and spread out in sheets of a fraction of an inch or so in thickness it became intercalated with clay, sand, gravel, and wind-blown material. The resulting product is a rudely stratified material consisting of fine and coarse sediments more or less uniformly saturated with petroleum. Vander Hoof contends that it was mainly during the summer months that the oil became fluid enough to spread over large

areas; while the winter rains carried in most of the clastic material."

With this statement our findings agree, but with the suggestion of a lake, which had also seemed the case to us, the writer is at present inclined to think such an explanation entirely unnecessary. The larval forms that were present could have developed just as well in little pools lying on the surface of the more or less liquid tar. While the country today is very barren, there is water underground, because we found a seepage of water below the 6 ft. level at Site 4. Probably in the spring the rains form little pools sufficient for water insects to breed in. The chances are that this has been the state of affairs for long periods of time. Buena Vista Lake, a few miles away, is close enough to have been the source of the flying water insects.

The present report is upon the Bessom findings mainly, as it will take a long time to explore the materials obtained on November 2. Figure 1 illustrates a clump of matrix asphalt from the 4 ft. level at Site 4, just as found, and one can recognize two abdomens and a head of a dragon fly, the head of a large Hydrophilid at the edge of the clump opposite the dragon fly head; three or four beetles, and the wing of a water boatman (Corixidæ).

The Bessom Site 4 material is quite different from the 1945 material in that dragon flies and damsel flies are dominant. The condition of the insects suggests very little movement from the point of death. (The modern dragon flies caught in the seepage died at the spot where they alighted, without any movement, as their feet were caught). They are filled with asphalt permeated fine silt, and many of the insects are entire, except for the wings. One striking point is that the eyes are often present, although sometimes loose in the sockets, in dragon flies, beetles, wasps, flies, and moths. Figure 2 is an enlargement of the dragon fly head in Figure 1, and clearly shows the pattern of the eyes.

The Bessom material has yielded several species of dragon flies, damsel flies, and even damsel fly larvae. Packed in closely with them are many whole predaceous diving beetles, family Dytiscidæ, of which the genera *Cybister, Colymbetes,* and *Agabus* have been separated out. The giant water scavenger beetles (Hydrophilidæ) were also numerous, and belonged to the genera *Hydrous* and *Tropisternus.*

The crawling water beetles of the family Haliplidæ, genus *Haliplus,* were present in small number.

Also there were 5 families of water bugs. The back swimmers, Notonectidæ, are represented by a new species of *Notonecta,* which was common. The water boatman, Corixidæ, are repre-

sented by two genera. The rare Nepidæ, or water scorpions, are represented by two new species of *Ranatra;* the water striders, Gerridæ, by a species of *Gerris;* the giant water bugs, Belostomatidæ, by two species, a *Lethocerus,* and a *Belostoma.* This makes 10 families of exclusively water dwelling insects; and in addition our material contains the mud beetles, Heteroceridæ, genus *Heterocera;* and a tiger beetle, Cicindelidæ, genus *Cicindela.*

Scavenger insects are nowhere near in the proportion that they are in Rancho La Brea; and of course, insect remains far outnumber the bird, rodent, and toad bones found in the 4 ft. level. To date only a Silphid (genus *Nicrophorus*), and a few Diptera have been found.

Predaceous beetles of the Carabidæ are not common; a few Staphylinidæ have been found. At the 2 ft. level I found some Tenebrionidæ, but there have been none from the 4 ft. level.

Incidentally there are remains of grasshoppers (Acrididæ), and Jerusalem crickets (Gryllacridæ), among the Orthoptera; a few badly mangled moths, which will be difficult to determine (order Lepidoptera); fragments of several kinds of wasps (order Hymenoptera), including cuckoo wasp (Chrysididæ) and paper wasp (Vespidæ); one dung beetle, Scarabæidæ; one wood borer (Buprestidæ).

The material now on hand will take a long time to study, but the collection of this by definite levels will make it possible to get relative timing on the insects, and small vertebrates.

The figuring of age will be difficult, because the deposits have been spasmodic and very slow. From the external appearance of the strata, the different colors of the asphaltum indicate very distinct periods of time. We must leave the calculation to the stratigraphers. What we are interested in is the existence of a continuous series of deposits full of interesting material. The farther down we go the older it is.

The following articles, to be subsequently published, will show that some, at least, of the insects are not known today, and hence must be considered as new species.

THE TOLERANCE OF RODENTS TO THE FEEDING OF CONE-NOSED BUGS (Hemiptera, Reduviidae)*

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INTRODUCTION

The writer has previously pointed out the remarkable adaptability of rodents as laboratory hosts of haematophagous bugs (Wood, 1943). This paper, based on feeding data recorded from 1938 through 1942 on cultures of *Triatoma* harboring *Trypanosoma cruzi* Chagas, gives additional information on rodent tolerance to bug exposures. Where possible, the number of bugs that were seen to feed is specified, including mention of those which fed to capacity. Where animals are mentioned as exposed to feeding, no note was taken of the exact number which fed although some bugs fed on the rodent at every exposure. Where the remark "most fed" is made, the majority of the insects in the moist chamber had fed although no count was made at the time. For details of technique in feeding and caring for *Triatoma* see Wood (1941b).

The following species of cone-nosed bugs were used: *Triatoma protracta, T. protracta woodi, T. rubida, T. longipes, T. gerstaeckeri, T. heidemanni, T. sanguisuga* and *Paratriatoma hirsuta.* These insects with the exception of *Paratriatoma* will hereafter be referred to by their specific names. Instar equivalents for nymph sizes are as follows: *protracta* and *protracta woodi,* large (4th and 5th), medium (2nd and 3rd), small (1st); *rubida, heidemanni* and *P. hirsuta,* large (5th), medium (3rd and 4th), small (1st and 2nd); and *longipes* and *gerstaeckeri,* large (4th and 5th), medium (3rd), small (1st and 2nd).

Where weights of rodent hosts and experimentally infected animals are specified, they refer to the weight before first bug exposure or inoculation.

OBSERVATIONS

NATIVE RODENTS: One adult Gambel white-footed mouse, *Peromyscus maniculatus gambeli,* survived the feeding of 1 medium and 9 large nymphs, 1 male and 1 female (adults) and ex-

*Presented in part before The Western Society of Naturalists at the 15th Annual Winter Meeting on December 28, 1945, Mills College, Oakland, California.

posure to feeding of 14 medium and 3 large nymphs of *protracta* over a 12 hour period.

One adult male southern parasitic mouse, *Peromyscus californicus insignis,* survived the feedings of 8 small and medium *rubida* nymphs and 4 medium *longipes* nymphs over a 12 hour period with no apparent ill effects to the mouse. Another adult survived the feeding of 1 large nymph and 1 female *protracta* and exposure to feeding of 13 small and medium *rubida* nymphs on November 17th and exposure to the feeding of 48 small, medium and large *protracta* nymphs on November 28th and December 5th. Many of the latter group of bugs fed on the mouse both times with no apparent ill effects to the rodent.

One adult female southern parasitic mouse survived exposure to feeding of 22 bugs including 12 medium *gerstaeckeri* nymphs, 6 small and medium *rubida* nymphs and 1 medium *heidemanni* nymph on November 17th and 3 large *rubida* nymphs on November 28th. There were no apparent ill effects to the mouse.

One adult female San Diego wood rat, *Neotoma fuscipes macrotis,* survived the feeding of 14 medium and large *protracta* nymphs on November 1st, 11 small *protracta* nymphs on December 20th, 2 large nymphs and 1 male *protracta woodi* and 9 medium and 2 large *rubida* nymphs on December 22nd. It was exposed to the feeding of 1 medium and 1 large nymph and 1 female *protracta,* 1 large nymph and 1 male *protracta woodi* and 2 large *rubida* nymphs on November 1st and 16 medium and large *protracta* nymphs on December 20th with no apparent ill effects to the rat.

An adult female southern parasitic mouse served to feed 1 small, 10 medium and 2 large *rubida* nymphs but died after exposure to 9 small, 59 medium and 20 large *protracta* nymphs over a period of four days. Most of the 88 *protracta* fed.

Over a 3 day period, an adult female San Pedro Martir white-footed mouse, *Peromyscus truei martirensis,* served to feed 17 small and 7 medium and large *protracta* nymphs, 1 medium and 2 large *longipes* nymphs, and 28 small *rubida* nymphs. The mouse died on the third day while exposed to 9 large nymphs and 1 male *protracta woodi* involving a total exposure to the feeding of 65 bugs.

IN ANIMALS EXPERIMENTALLY INFECTED WITH *Trypanosoma cruzi,* an adult male, 35 gram southern parasitic mouse, experiment 50, served to feed 10 small *protracta* nymphs on the 14th day after inoculation and was exposed to 82 small *protracta* nymphs on the 18th day. Most of the bugs fed and many fed again on the 25th day when placed with the mouse. The animal was discarded on the 90th day in apparent good health.

An adult female, 35 gram southern parasitic mouse, experiment 56, which showed a heavy *Trypanosoma cruzi* infection, served to feed 19 small *protracta* nymphs on the 18th day after inoculation, 4 small *protracta* nymphs on the 19th day and 8 small *longipes* nymphs on the 30th day. This mouse was exposed to the feeding of 26 small *protracta* nymphs (most fed) on the 19th day, 25 small *protracta* nymphs (most fed) and 34 small *rubida* nymphs on the 21st day, 20 small *longipes* nymphs (most fed) on the 31st, 32nd and 36th day. The mouse was anesthetized on the 90th day in apparent good health.

An adult male, 37 gram southern parasitic mouse, experiment 76, served to feed 15 small *protracta* and 2 small *longipes* nymphs on the 19th day and was exposed to 24 small, medium and large nymphs, 1 male and 3 female *protracta* (most fed) on the 16th day. The mouse was apparently in good health when sacrificed for tissue studies on the 22nd day after inoculation.

An adult male, 38 gram southern parasitic mouse, experiment 79, served to feed 41 and 67 small *protracta* nymphs on the 22nd and 48th days, respectively. It was exposed to the feeding of 14 nymphs and 6 adult *protracta* on the 26th day, 30 small *protracta* nymphs on the 32nd day, 14 nymphs and 2 adult *protracta* and 22 small *rubida* nymphs on the 47th day and 58 small *protracta* nymphs on the 48th day with no apparent ill effects.

An adult female, 45 gram southern parasitic mouse, experiment 91, was exposed to the feeding of 31 small *protracta* nymphs on the 14th day, 31 small *protracta* and 44 small *gerstaeckeri* nymphs on the 16th day, and 44 small *gerstaeckeri* nymphs and 34 small and 53 medium nymphs and 18 female *protracta* on the 28th day with no apparent ill effects to the mouse.

An adult male, 20.5 gram white-footed mouse, *Peromyscus crinitus stephensi*, experiment 98, was exposed to the feeding of 49 and 80 small *protracta* nymphs on the 18th and 22nd days, respectively, with no apparent ill effects to the mouse.

An adult male white-throated wood rat, *Neotoma albigula albigula*, experiment 81, served to feed 9 female *rubida* and 2 medium and 2 large *longipes* nymphs on the 20th day, 17 small *rubida* nymphs on the 40th day and 2 medium and 2 large nymphs and 1 male *longipes* on the 47th day. The rat was exposed to the feeding of 30 small *protracta* nymphs on the 32nd and 38th days and 66 small, medium and large *protracta* nymphs, 17 small and 8 medium *rubida* nymphs (most fed), and 7 medium *longipes* nymphs on the 47th day with no apparent ill effects to the rodent. An uninfected adult female rat, as reported previously (Wood, 1943, p. 318), survived 1,016 feedings over a period of 6 months.

An adult male, 41.5 gram southern parasitic mouse, experiment 78, died after exposure to the feeding of the following bugs:

1 large nymph and 2 female *rubida* on the 32nd day, 30 small *protracta* nymphs and 1 large *longipes* nymph on the 89th day and 11 medium *protracta* nymphs and 17 medium *rubida* nymphs on the 90th day. Another adult male, 38 gram southern parasitic mouse, experiment 95, died after being fed on by 67 small *rubida* nymphs on the 22nd day and 2 small, 2 medium and 19 large nymphs, 1 male and 1 female *protracta* on the 55th day after inoculation.

An adult female, 18.5 gram white-footed mouse, *Peromyscus crinitus stephensi,* experiment 97, died after being fed on by 32 small *rubida* nymphs on the 20th day and 6 large nymphs, 4 male and 5 female *protracta* on the 22nd day, although an uninfected male (Wood, 1943, p. 318) survived exposure to 61 small *longipes* nymphs.

LABORATORY RODENTS: Over a 10 hour period, one male white mouse, *Mus musculus,* survived being fed on by 1 small nymph, 1 male and 1 female *protracta* and another survived being fed on by 12 nymphs and 5 adult *Paratriatoma hirsuta.* Another adult male weighing 26.5 grams survived the feeding of 77 small *protracta* nymphs (Wood, 1943, p. 318).

Table 1 summarizes the results on feeding exposures for 30 uninfected and 3 experimentally infected white rats, *Rattus norvegicus.*

Two young white rats died after overnight feeding of 39 medium and large *protracta* nymphs. A young hooded white rat died after feeding of 31 small and 31 medium (partly fed) *protracta* nymphs and 17 small *gerstaeckeri* nymphs over a 48 hour period.

A half-grown white rat died after feeding of the following bugs from July 3 to August 9: 24 medium, 14 medium and large nymphs, 3 female and 1 male *protracta;* 65 small and 20 medium *rubida* nymphs (exposure to 27 small and 20 medium nymphs); 4 medium *longipes* nymphs; and 3 medium (fed to capacity) and 1 large *gerstaeckeri* nymphs, a total of 182 bugs of which 145 are known to have fed.

An adult white rat died after feeding of the following bugs over a 36 hour period: 9 medium and large, 6 medium, and 6 large nymphs, 1 male, and 5 female *protracta;* 26 small and 37 medium *rubida* nymphs; 2 medium *longipes* nymphs; and 1 medium and 1 large *gerstaeckeri* nymphs.

An adult female white rat, weight 205 grams, died after being fed on by the following: March 4, 454 small *longipes* nymphs; March 5, 1 male *Paratriatoma hirsuta,* 41 small, 46 small and medium nymphs and 1 female *protracta,* 29 small, and 41 small and medium *rubida* nymphs; March 6, 75 small *rubida* nymphs; March 10, 77 small *rubida* nymphs; March 11, 12 medium *longipes*

nymphs, 4 small, 1 medium, 2 large nymphs and 1 female *Paratriatoma hirsuta,* and 37 small and 38 small and medium *rubida* nymphs; and March 13, 2 female *protracta* fed to capacity and 13 medium nymphs of *longipes* fed before the rat died. Thus, this rat succumbed after 875 feedings of individual *Triatoma* and *Paratriatoma* over a 9 day period.

Five guinea pigs were exposed at irregular intervals to the feeding of cone-nosed bugs. There was no evidence of injury to any of these animals even after a maximum exposure to feeding of 949 small *longipes* nymphs over a 12 hour period.

From April 1st through April 4th, an adult male guinea pig, no. 1, served to feed 2 medium, 6 large and 16 medium and large *protracta* nymphs, 4 large *protracta woodi* nymphs, 2 medium and 5 large *rubida* nymphs, 2 large *longipes* nymphs, and 4 small *gerstaeckeri* nymphs. It was also exposed to the feeding of 28 small and 15 small and medium *protracta* nymphs. Forty-one bugs were seen to feed and laboratory notations indicate that most of the remaining 43 fed some over the 3 day exposure period.

From November 2, 1940 to February 4, 1941, another adult male, no. 2, served to feed 2 medium and 4 large nymphs, 1 male and 1 female *protracta,* 33 small, medium and large, 2 medium and 41 large *rubida* nymphs, 17 small *longipes* nymphs, 1 large *heidemanni* nymph and 3 female *gerstaeckeri* and was exposed to the feeding of 15 small and medium and 1 large *protracta* nymphs, 5 large *protracta woodi* nymphs, and 41 small, medium and large, 244 small and 50 large *rubida* nymphs (many fed). Thus, this guinea pig was exposed to the feeding of 461 *Triatoma* of which 105 bugs were actually observed to feed.

From October 26, 1940 to February 5, 1941, another adult male, no. 3, served to feed 50 small nymphs and 1 female *protracta,* 6 large *protracta woodi* nymphs, 36 small and 43 large *rubida* nymphs, 151 small *longipes* nymphs, 8 small *gerstaeckeri* nymphs and 2 medium *Paratriatoma hirsuta* nymphs and was exposed to the feeding of 52 small nymphs and 1 female *protracta,* 167 small *rubida* nymphs, 393 small and 47 medium and large *longipes* nymphs, 3 large nymphs and 1 male *heidemanni,* 48 small nymphs and 1 female *gerstaeckeri* and 5 small, medium and large *Paratriatoma hirsuta* nymphs. This guinea pig survived in good condition a total of 1015 exposures including 297 observed feedings.

From April 10, 1941 to February 23, 1942, an adult male, no. 4, served to feed 28 small and medium, 28 medium and large nymphs and 1 female *protracta,* 3 large *protracta woodi* nymphs, 1 medium and 4 large nymphs and 18 female *rubida,* 7 medium and large nymphs, 142 male and 57 female *longipes* and 1 large *heidemanni* nymph. This animal was exposed to the feeding of 10 small and 84 small, medium and large *protracta* nymphs (most

fed); 151 small *rubida* nymphs (most fed); 39 small and 2 large nymphs, 51 male and 11 female *longipes* (many fed); and 7 small *gerstaeckeri* nymphs. Thus, this guinea pig survived in good condition a total of 645 exposures including 290 known feedings.

From April 12 to December 6, 1941, an adult female, no. 5, served to feed 10 small and 1 large nymph and 4 female *protracta,* 5 large nymphs and 1 male *protracta woodi,* 289 small nymphs, 60 male and 105 female *rubida,* 447 small and 9 medium *longipes* nymphs, 14 small and 8 medium *gerstaeckeri* nymphs and 8 small, 4 medium and 4 large nymphs, 2 male and 3 female *Paratriatoma hirsuta.* It was exposed to the feeding of 138 small nymphs, 1 male and 3 female *protracta;* 1646 small, 173 small and medium and 82 large nymphs, 29 male and 43 female *rubida;* 5150 small, 9 medium, 105 small and medium nymphs, 3 male and 4 female *longipes;* and 6 small *gerstaeckeri* nymphs. Thus, this guinea pig survived a total of 8366 feeding exposures including 974 observed feedings.

IN ANIMALS EXPERIMENTALLY INFECTED WITH *Trypanosoma cruzi,* five male white mice weighing between 23.5 and 26 grams showed no ill effects from feeding of 10 each (3 mice), 15 (1 mouse) and 25 (1 mouse) small *protracta* or *rubida* nymphs between the 17th and 31st days after inoculation. All were anesthetized by the 93rd day after inoculation.

An adult male, 22 gram white mouse, experiment 43, which survived a heavy infection with *Trypanosoma cruzi* served to feed 34 small *protracta* nymphs on the 15th day, 24 small *rubida* nymphs on the 17th day, 3 medium *gerstaeckeri* nymphs on the 26th day and 1 medium *gerstaeckeri* and 1 medium *sanguisuga* nymph on the 28th day. This mouse, which had injured its eye in the wire cylinder (Wood, 1941c, pp. 3 and 4) on the 7th day after inoculation was anesthetized on the 120th day. It was weak and thin and both ears were infested with mites, *Ereynetes concolor* Haldman.

Another adult male, 16.5 gram white mouse, experiment 49, served to feed 1 large nymph and 5 adult *protracta woodi* on the 51st day and 15 small *protracta* nymphs, 10 small and 1 large nymphs and 4 male *protracta woodi,* and 7 small *longipes* nymphs on the 109th day after inoculation with no apparent ill effects to the mouse.

An adult male, 21 gram white mouse, experiment 82, served to feed 2 female *rubida* on the 28th day and 21 medium and large *protracta* nymphs (most fed) on the 47th day with no apparent ill effects.

Another adult male, 24 gram white mouse, experiment 86, served to feed 25 small *rubida* nymphs on the 34th day and was

exposed to the feeding of 12 small *protracta* nymphs (most fed), and 89 small *rubida* nymphs (many fed) on the 36th day and 23 nymphs, 1 male, 2 female *protracta* (most fed), 36 small *rubida* and 23 small *gerstaeckeri* nymphs (a few fed) on the 44th day with no subsequent ill effects to the mouse.

An adult male, 21 gram white mouse, experiment 88, was exposed to the feeding of 38 small *protracta* nymphs and 23 small *gerstaeckeri* nymphs on the 32nd day after inoculation. This mouse was so active in the wire cylinder that most of the bugs did not feed. Another adult male, 22 gram white mouse, experiment 94, was exposed to the feeding of 41 small *protracta* nymphs and 67 small *rubida* nymphs on the 20th day. An adult male, 28 gram white mouse, experiment 109, served to feed 5 small and 1 medium nymph and 2 female *protracta*. No apparent ill effects were noted in any of these mice.

An adult male, 25.5 gram white mouse, experiment 63, succumbed to the feeding of 18 medium and large nymphs and 1 female *protracta* on the 27th day after inoculation. Another adult male, 22 gram white mouse, experiment 84, served to feed the following small *protracta* nymphs: 18 on the 20th day and 29 on the 22nd day and was exposed to the feeding of 19 on the 22nd day (most fed) and 18 on the 23rd day. The mouse was very weak and died on the 24th day after inoculation.

An adult male, 21 gram white mouse, experiment 85, served to feed 2 small *longipes* and 18 small *gerstaeckeri* nymphs on the 27th day and was exposed to the feeding of 23 small, medium and large nymphs, 1 male and 2 female *protracta* and 39 small *rubida* nymphs on the 26th day, 12 small *protracta* nymphs on the 27th day, and succumbed while exposed to 51 small *rubida* nymphs on the 28th day.

An adult male, 20 gram white mouse, experiment 87, showing a heavy infection with *Trypanosoma cruzi*, served to feed 23 small *rubida* nymphs on the 18th day and 45 small *rubida* nymphs on the 28th day. This mouse was very weak and was found dead in its cage on the 29th day after inoculation. It was parasitized by the mite, *Ereynetes concolor* Haldman.

Another adult male, 21 gram white mouse, experiment 89, with a heavy infection of *Trypanosoma cruzi*, served to feed 11 small *protracta* nymphs on the 12th day, 34 small *rubida* nymphs on the 20th day and 12 small, medium and large *protracta* nymphs on the 28th day. It was exposed to 29 small *gerstaeckeri* nymphs (a few fed) on the 16th day and 21 small *protracta* nymphs (most fed), 16 small and 5 medium *rubida* nymphs, 24 small *gerstaeckeri* nymphs and 1 male and 1 female *heidemanni* on the 28th day. The mouse died on the 28th day.

A male, 22 gram white mouse, experiment 90, served to feed 24 small *rubida* nymphs on the 22nd day, 10 small *rubida* nymphs on the 26th day, and 10 medium and large *protracta* nymphs on the 32nd day. It was exposed to the feeding of 32 small *rubida* nymphs on the 32nd day and 8 medium *protracta* nymphs on the 33rd day when it died.

Another adult male, 22 gram white mouse, experiment 92, died after exposure to feeding of 18 small *protracta* nymphs on the 20th day and 1 female *protracta*, 10 medium and large nymphs and 1 male *protracta woodi*, 4 small and medium *rubida* nymphs and 4 medium and large *longipes* nymphs on the 22nd day.

A male, 52 gram white rat, experiment 96, served to feed 66 small *rubida* nymphs on the 23rd day and succumbed to exposure to feeding of 21 medium and large *protracta* nymphs, 31 small, medium and large *rubida* nymphs (most fed) and 7 medium *longipes* nymphs (most fed) on the 25th day.

DISCUSSION

The number of cone-nosed bugs collected in surveys (de Shazo, 1943; Packchanian, 1939, 1940; Wood, 1942); or found in specific localities, as at the Alvarado Mine near Congress Junction, Arizona (Wood, 1943); or which periodically seem to increase abnormally in abundance as reported in the "kissing bug scare of 1899" (Wood, 1941a) would seem to indicate a large animal reservoir of food for these insects in nature. That elements of the native mammal population can furnish an ample food source for these bugs is indicated here by the efficiency of rodents to supply blood at daily, weekly or monthly intervals.

Rodents rarely would be subjected to massive bug feedings in nature since the average number encountered in 451 wood rat houses was 2.88 bugs per house (Wood, 1941d). Since houses of wood rats are usually occupied by one adult, except during the breeding cycle, their support of large bug populations is doubtful. The maximum number of bugs collected from one wood rat house was 85 *Triatoma protracta* in California and 76 *T. p. woodi* in Texas (Wood, 1941b). Both of these records were from nests harboring female and young rats. In a thorough study of 100 wood rat dens, Vorhies and Taylor (1940) found 59% containing from 1 to 10 *Triatoma*.

Bat caves with well established resident populations have been found to harbor *Triatoma* and probably support big bug populations. Clark and Dunn (1931) report that all stages of *Triatoma geniculata* were found in bat caves indicating breeding of the bug there. These big bat concentrations would seem to offer a good

source of food for cone-nosed bugs although great difficulties would be encountered in collecting the bugs because of the structure of the caves. The writer found one *T. longipes* nymph in a mine shaft occupied by bats at the Alvarado Mine in Arizona (Wood, 1943, p. 316). Possibly other caves in the vicinity are the source of some adult bugs attracted to the miner's houses during the warmer parts of the year.

SUMMARY

Among the native rodents, 10 white-footed mice (*Peromyscus*) survived feedings of 10 to 108 cone-nosed bugs and exposure to feeding of as many as 255 bugs. Five *Peromyscus* died after feeding of from 47 to 92 *Triatoma.* Two wood rats (*Neotoma*) survived the feeding of as many as 39 bugs and exposure to 158 bugs. Of the laboratory rodents, 14 white mice survived feedings of from 3 to 63 cone-nosed bugs and exposure to feeding of as many as 211 (25 fed) bugs. Seven white mice succumbed to the feeding of 19 and 68 bugs and exposures to 38, 84(2), 148 and 154 bugs. Thirty-three white rats of different ages survived feedings of from 14 to 317 cone-nosed bugs over various time intervals. White rats survived exposure to as many as 130 bugs over a 7 hour period and 855 possible feedings over a 62 day period. Seven white rats died after feeding of as few as 39 (24 hour period) and as many as 875 (9 day period) bugs. Five guinea pigs survived feedings of 41, 105, 290, 297 and 974 bugs involving exposures to feeding of as many as 949 bugs over a 12 hour period and 8,366 cone-nosed bugs over an 8 month period. No differences in tolerance were noted in animals experimentally infected with *Trypanosoma cruzi* Chagas.

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TABLE 1
Cone-nosed bug feeding records on surviving *Rattus norvegicus*.

No.	Rat		Wt. Grams	Reduviid Species	Bugs Fed					Total Bugs Fed and Exposed	Time Exposed*
					Adults			Nymphs			
	Sex	Age			M	F	L	M	S		
1		Imm		*protracta*		2	19			226	6½ months
				longipes					1		
				gerstaeckeri		1			20		
2		Imm		*protracta*					40	40	48 hours
3		Imm		*protracta*					90	219	4 days
4		Imm		*protracta*				139		273	5½ months
				rubida					30		
5		Imm		*protracta*					106	106	24 hours
6		Imm		*protracta*					113	113	24 hours
7		Imm		*protracta*					52	52	12 hours
8		Imm		*protracta*					52	52	48 hours
9		Imm		*protracta*	2	4	3	2	26	133	7 days
				rubida					84		
				longipes				2			
				gerstaeckeri				10			
10		Imm		*protracta*					29	29	10 hours
11	♂	Imm		*protracta*					113	113	10 hours
12	♂	Imm		*protracta*					21	21	10 hours
13	♀	Imm		*protracta*					32	32	10 hours
14	♀	Imm		*protracta*					21	21	10 hours
15	♀	Imm		*protracta*	1	7	9	6		79	10 hours
				rubida			16	27	11		
				gerstaeckeri			1	1			
16	♂	Ad		*protracta*					107	107	10 hours
17	♂	Ad		*protracta*					47	47	10 hours
18	♂	Ad		*protracta*				52		52	10 hours
19	♂	Ad		*protracta*					38	38	10 hours
20	♂	Ad		*protracta*				14		14	10 hours
21	♂	Ad		*protracta*		1	3	14		52	82 hours
				protracta woodi	1		3				
				rubida		1	1				
22	♂	Ad		*protracta*	1	7	11	6		83	10 hours
				rubida			16	27	12		
				longipes			1				
				gerstaeckeri			1	1			

TABLE I—(*Continued*)

Rat No.	Rat Sex	Rat Age	Wt. Grams	Reduviid Species	Bugs Fed: Adults M	Adults F	Nymphs L	Nymphs M	Nymphs S	Total Bugs Fed and Exposed	Time Exposed*
	♂	Ad	212	*protracta*	1	1	7	24		57	10 hours
				rubida					22		
				longipes	1	1					
	♂	Ad	160	*protracta*		1	15	16	26	130	7 hours
				rubida			1	16	9		
				longipes				32	14		
	♂	Ad	154	*protracta*	1	1	4	24	16	168	82 hours
				rubida		2	7	26	50		
				longipes	10	3		9	10		
				gerstaeckeri			3	2			
	♀	Ad	151	*protracta*				70		93	10 hours
				longipes				4			
				gerstaeckeri		4	6	3			
				P. hirsuta	1	2	1	2			
7	♀	Ad	111.5	*protracta*		1	4	10	13	40	10 hours
				rubida					6		
				longipes		1					
				gerstaeckeri			4	1			
3	♀	Ad	160	*protracta*				59	7	66	10 hours
9	♀	Ad		*protracta*			1		46	76	5 days
				rubida			3	14	1		
				heidemanni				1			
0	♀	Ad		*protracta*			5		50	855	59 days
				rubida		1	6	20	138		
				gerstaeckeri				26	61		
				heidemanni	3	1			6		
32	♀	Imm		*protracta*					107	107	7 days
35	♂	17 days		*longipes*					15	15	2 hours
36	♂	Imm		*protracta*					10	10	2 hours

*Time exposed refers to actual exposure indicated in hours only. Other exposures refer to discontinuous daily contacts over the entire time period. Additionally, no. 1 was exposed to the feeding of 14 male, 5 female, 35 large, 78 medium and 43 small nymphs of *protracta* and 8 small *rubida* nymphs. No. 3 was exposed to 2 male and 91 small nymphs of *protracta* and 36 small *rubida* nymphs. No. 4 was exposed to 2 male and 102 medium nymphs of *protracta*. No. 21 was exposed to 1 female, 4 large and 16 small nymphs of *protracta*, 4 large *protracta woodi* nymphs, and 1 female, 1 large and 1 medium nymph of *rubida*. No. 24 weighed 148.5 grams and no. 26 weighed 133.5 grams after exposure. No. 29 was exposed to 10 medium *gerstaeckeri* nymphs. No. 30 was exposed to 10 male, 3 female, 6 large, 21 medium and 327 small nymphs of *protracta*, 22 male, 15 female, and 116 small nymphs of *rubida*, 1 male and 4 small nymphs of *heidemanni* and 13 small *gerstæckeri* nymphs. E32, E35 and E36 were experimentally infected with *Trypanosoma cruzi*.

BULLETIN of the SOUTHERN CALIFORNIA
ACADEMY of SCIENCES

Published by the Academy at Los Angeles, California
Subscription—$2.00 per year

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Bulletin, Southern California Academy of Sciences

Vol. XLVI, ~~1948~~ 1947

INDEX OF SUBJECTS

New varieties and species indicated in **bold face type**

INDEX OF AUTHORS

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LOS ANGELES, CALIFORNIA

VOL. XLVII JANUARY-APRIL, 1948 PART I

CONTENTS

Issued July [illegible], 1948

Southern California Academy of Sciences

Bulletin, Southern California Academy of Sciences

VOLUME 47 - - - - - - - PART 1, 1948

LIFE HISTORY OF HESPERIA LEONARDUS HARR

By V. G. DETHIER
The Johns Hopkins University

This conspicuous skipper is locally abundant in northern New England from late August till the advent of frost. Its late seasonal appearance may explain in part why its life history has never been worked out completely. The egg and first two instars have been described by Scudder (1889) and Dethier (1939). The remaining stages are described below.

THIRD INSTAR: Head width, 1.4 mm.; head height, 1.5 mm. Head dark fuscous. Evenly marked with large piceous punctations except in a vertical line adjacent to the epicranial suture, in the frons, the adfrontal areas, and the region of the ocelli. The color pattern of the species appears unmistakable in this instar. The markings are light cream to light brown against a darker brown to black background. Hairs are short, colorless, pointed, and inconspicuous. Body length, 6 to 10 mm. The larva is now darker than before. Its body is finely and irregularly mottled with white and maroon. Hairs short and spine-like but still slightly spatulate.

FOURTH INSTAR: Head width, 1.8 mm.; head height, 1.9 mm. The color pattern is now pronounced but does not differ markedly

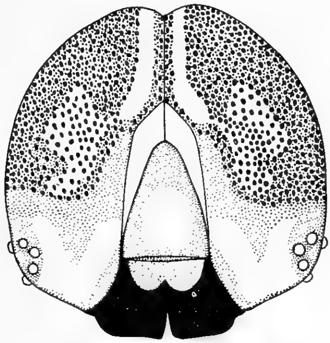

PLATE 1

Head of fifth instar larva of *Hesperia leonardus* Harr. showing distribution of distinctive color pattern and piceous punctations.

from the previous instar. Body length, 10 to 13 mm. Body darker and more brownish in general appearance, otherwise no conspicuous change.

Fifth Instar: Head width, 2.52 mm.; head height, 2.6 mm. Pattern as figured. Punctations larger than before. Body length, 13 to 17 mm. Body becoming lighter.

Sixth Instar: Head width, 3.4 mm.; head height, 3.7 mm. No change in pattern. Body length, 17 to 30 mm. No marked change.

Chrysalis: Length, 19 mm. Color rather nondescript brown and green. No conspicuous color markings. Salient structural characteristics are shown in the accompanying photograph.

PLATE 2
Chrysalis of *Hesperia leonardus* Harr.

The larva of this species is most easily confused with the smaller *Polites themistocles.* It can be distinguished from *P. themistocles* by the absence of any pattern on the anal plate, by the less intense yellow of the head markings, the more pronounced V near the ocelli, the less reddish overall appearance of the head, and the presence of a few remaining spatulate hairs on the body.

The insects upon which the above descriptions are based emerged September 25 from eggs laid August 30. Moulting occurred October 1, 13, 23, and 29, November 6 and 27. The first instar required six days; the second, twelve days; the third, nine days; the fourth, six days; the fifth, eight days; the sixth, twenty-one days; pupation, sixteen days.

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THE LARVA AND PUPA OF EUMÆUS DEBORA Hbn.

By JOHN A. COMSTOCK

Three species of the Genus *Eumæus* have thus far been reported for the American continent, namely *Eumæus atala* Poey, *E. minyas* Hbn., and *E. debora* Hbn.

The first named of these occurs in southern Florida, the Florida Keys and Cuba, where the larva has been reported as feeding on *Zamia integrifolia* Willd., a native Cycad, commonly called "Coontie," and also on certain introduced plants of the genus *Manihot.*

The last two instars, and the pupa, were described and illustrated by Scudder in 1875,[1] and the life history recorded by E. A. Schwartz in 1888.[2] John L. Healy of Chicago also published two short papers on *E. atala* in 1910.[3]

The second species, *Eumæus minyas* Hbn., ranges from southwestern Texas to Brazil. We know of no published account of its metamorphosis but its early stages are doubtless very similar to those of *atala,* and it probably feeds on the same foodplants. There are no native Cycads growing in Texas, but *Manihot carthaginensis* Muell, locally known as "Yuquilla" is indigenous in the southern part of the state and may account for the butterfly having been taken there.

Seitz[4] described two subspecies of *minyas,* one occurring in Costa Rica, which he designated *costaricensis,* and the other from the Amazon which he named *brasiliensis.*

The third species, *Eumæus debora* Hbn., ranges from Mexico to Guatemala. Dr. M. Draudt, in Seitz, says that "the carmine, black-belted larva lives gregariously on an Amaryllis standing in water." His reference does not give the specific name of the plant and the designation of "black-belted" does not tally with larva reared by us, unless the sparse black hairs crossing the center of the segments gives an impression of black bars.

Dr. E. Yale Dawson secured a number of larvæ on February 10, 1947, while collecting plants in the State of Tamaulipas, in a locality between Antigo Morelas and Mante, Mexico. They were feeding on *Dioon edule* Lindl., a Cycad that is native to the area.

---

[1]Mem. Boston Soc. N. History. 2: 413. pl. 114. 1875.
[2]Insect Life. U. S. D. A. Vol. 1, p. 37. figs. 1888.
[3]Ent. News. 21: 179 and 327.
[4]Macrolep. Vol. 5, p. 745. 1919.

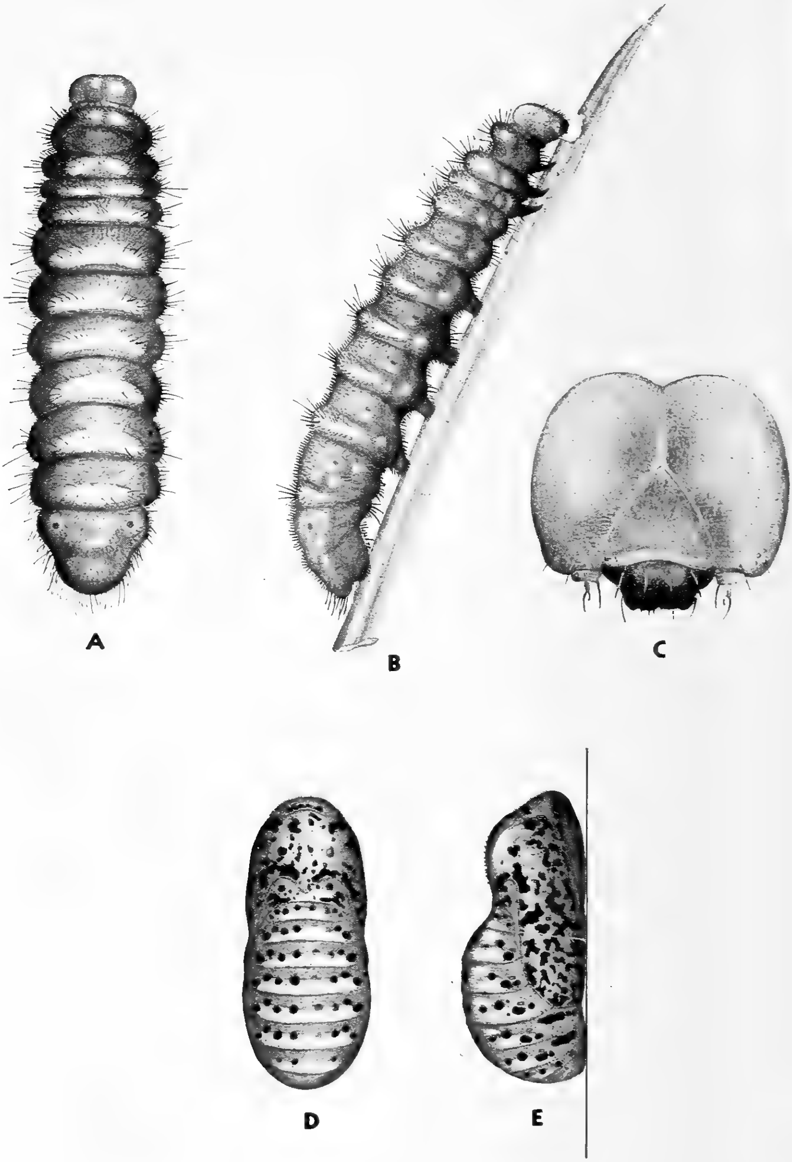

PLATE 3

Larva and pupa of *Eumæus debora* Hbn.

FIGS. *a* and *b*, mature larva, dorsal and lateral aspects, enlarged X 2 1/3.
FIG. *c*, head of larva enlarged X 10.
FIGS. *d* and *e*, pupa, dorsal and lateral aspects enlarged X 2 1/3.

Reproduced from painting by John Adams Comstock

These larvæ were transferred to *Cycas revoluta* Thunb (Sago palm) on February 18th, and were carried to maturity, thus enabling us to describe and illustrate the mature larva and pupa.

MATURE LARVA: Length, 30 mm. (average). Body, cylindrical, stout, and of about equal girth from the 3rd to the 11th segments.

Head relatively large for a Lycænid, and only retractile into the second segment to a slight degree. Color of head, light orange-scarlet; lobes well rounded. Mandibles, black. Antennæ, yellow. The few minute setæ occurring on the head are colorless, and almost indistinguishable even with a lens, except for a few near the mouth parts and ocelli.

Body ground color, deep scarlet. On the second to ninth segments there occurs an orange-yellow bar placed dorsally on the posterior half of each segment. This gives the larva a yellow-banded appearance. These bars do not extend laterally below the spiracles.

The dorsal and ventral surfaces of the body are sparsely covered with short black hairs, and a few long black stiff setæ are located on the yellow bars. These are approximately three times as long as the more numerous short hairs.

The spiracles are placed in a straight line, are darker than the ground color, and are not markedly conspicuous.

Legs, black, and well developed. Prolegs, concolorous with body.

The larva is illustrated on Plate 3, figs. A and B.

PUPA: Length, 17 mm. When fresh, the color is a deep scarlet, but soon changes to a ruddy brown. Rows of round black dots occur transversely across the abdominal segments, as shown in the illustration on Plate 3, figs. D and E. The thorax and wings bear numerous irregular black spots. Spiracles, black rimmed. Numerous short hairs occur on the thorax, and to a lesser extent on the mesothorax. The remainder of the surface is smooth, and free of visible setæ.

The shape is that of a typical Lycænid, with prominently rounded thorax and abdomen. A silken girdle, and also a pad of silk at the cauda attaches it to the surface on which it has pupated.

Imagos emerged the third week in March, 1947.

THREE APPARENTLY UNDESCRIBED GEOMETRID MOTHS FROM THE SOUTHWEST

By JOHN L. SPERRY
Riverside, California

During the latter part of June in 1947 Mrs. Sperry and the author made camp with Dr. and Mrs. Charles P. Alexander on the South Fork of the Little Colorado River in the White Mountains of Arizona. The collecting was fair both for Tipulids and Geometrids in spite of the dry season. On the 25th of June Mrs. Sperry, who always catches all the rare insects, took a single female belonging in the Hemitheinæ and this little green had given the author considerable trouble until Dr. Comstock and Lloyd Martin appeared with samples of their 1947 Santa Rita Mountains catch, in which there were four more of the species which the author pounced upon at once, and the presence of a male established the genus and allows the author to describe

CHLOROCHLAMYS MARTINARIA, n. sp.

MALE: Palpi, front, antennæ beneath and legs ochreous buff, antennæ above and collar light buff. Thorax, abdomen and all wings olive green (Ridgway color) heavily irrorate with gray white. The antennæ are short branched, the pectinations claviform, the apex dentate. Hind tibiæ swollen, with hair pencil and lacking median spurs; hind tarsi short. Abdomen tufted laterally on the eighth segment. Forewing, costa narrowly naples-yellow flecked more or less from base to apex with dark brown strigations. Most specimens show very obscure light lines; t.a. line, when present, from just beyond 1/3 out on the costa, narrow and irregular to inner margin at 1/3 out from base; t.p. line stronger, from ¾ out on costa bulging outward to the cell, concave across cell, curving outward again at line 3, inward again at line 2 and outward to inner margin at ¾ out from base. These lines are made of a thickening of the light strigations and the median area is slightly darker than the remainder of the wing. Discal dash can only rarely be seen as a slight darkening of the ground color, it is usually absent. On the secondaries the lines continue as on primaries, the t.a. line is usually obsolete and the t.p. line usually discernible though obscure. There is no discal dot. Fringes gray with tiny naples yellow dots basally at the ends of the veins. Beneath pale lumiere green with a silken lustre, the costa colored narrowly as above, the secondaries slightly lighter than the primaries. There are no strigations or discal dots on either wing.

The female is somewhat larger than the male, the lines stronger and tending to be accentuated on the veins by light spots especially on veins 1 and 2 of the primaries. There is a light green hair line at the base of the fringes broken by light dots on the veins and there is a shallow scallop of the outer margin at vein 5 of the secondaries. The antennæ are dentate and there is a square light spot dorsally on the third segment of the abdomen.

When faded in relaxing or from flying in the rain, the color of these insects is light ochreous buff with more or less tinge of green. Expanse, male, 17 to 20 mm.; female, 20 to 23 mm.

Holotype, male, Madera Canyon, Santa Rita Mountains, Ariz., August 15, 1947 (J. A. Comstock and Lloyd Martin) and in the collection of the Los Angeles County Museum.

Allotype, female, South Fork Camp, Little Colorado River, White Mountains, Ariz., June 25, 1947 (Grace H. Sperry) and in the collection of Grace H. and John L. Sperry.

Paratypes, 37 males, 20 females, Madera Canyon, Santa Rita Mountains, Ariz., July 16 to August 11, 1947, August 20 and August 30, 1946 (Dr. J. A. Comstock and Lloyd M. Martin) and in the Los Angeles County Museum, U. S. National Museum, Canadian National Museum, Museum of Comparative Zoölogy, American Museum of Natural History, British Museum and the Sperry collection.

It gives me great pleasure to name this interesting species in honor of our friend Mr. Lloyd M. Martin, Assistant Curator at the Los Angeles Museum, president of the Lorquin Club and one of the most active and enthusiastic lepidopterists it has ever been our good fortune to know. May there be many more Madera Canyons in his entomological pilgrimages and many more interesting species to enrich our lists of the fauna of the Southwest.

This species belongs immediately before *C. appellaria,* Pears. in the list, the pink color of the latter of course separating the species at once. The ædeagus in the male genitalia is the same needle-like type but the apex of the organ is more heavily decorated with small tooth-like cornuti. The size and obscure maculation separates the species from all others of the genus as do also the short clavate pectinations of the male antennæ.

Since 1934 there has been in the Sperry collection a single female specimen of the genus Drepanulatrix, species unknown. Through the kindness of Dr. J. A. Comstock and Lloyd Martin the author has been enabled to examine the species in the Los Angeles County Museum collection and to find therein three more specimens of this species, one of which being a male allows the author to describe.

DREPANULATRIX RUTHIARIA, n. sp.

Both sexes: Palpi, front and legs, light ochraceous buff; collar, thorax, abdomen and all wings cartridge buff (Ridgway color), antennæ gray-brown.

Male antennæ bipectinate, pectinations long, apex simple; female antennæ simple. Maculation of the wings brown-black. Forewings: there are two squarish heavy spots on the costa., the first, about 3/4 mm. square, just over 1/3 out on the costa the second, slightly smaller, at 2/3. There are two small spots on vein 1 near the inner margin at 4/10 and 7/10 out from the base, the lines which should connect these spots with those on the costa are almost entirely missing in the male and quite so in the female. The subterminal line of dark triangular dots which appears in so many species of this genus is indicated in the holotype by four indistinct spots which show the direction of the line to be from 1 mm. inside apex at costa curving inward across cell toward the place where the t.p. line should be thence parallel to the imaginary t.p. toward inner margin, fading out at vein 2. A small distinct discal dot, distad of and below the first costal blotch. Fringes concolorous with wing. Secondaries: A single line about 1/2 mm. wide from 2/3 out on inner margin goes straight toward the center of the wing, fading out as it reaches the cell. There is no discal dot; fringes concolorous with wing. All wings very sparsely irrorate with dark brown atoms. Beneath lighter, almost silky, no maculation, a minute discal dot on secondaries, none on primaries.

The maculation of the female is the same as that of the male but the spots are smaller and less distinct and the line on the secondaries tends to become obsolete. Expanse 27 to 28 mm.

I note that this species has been examined by Dr. McDunnough, Mr. F. H. Benjamin and Mr. Frederick Rindge, whose label states that it is close to *bifilata* Hulst, which is quite correct. The female genitalia offers little information except that it belongs near *bifilata* in the list. The male genitalia are almost identical but there seem to be two short spines in the armature of the vesica to three in *bifilata,* the valvæ seem shorter and broader and the saccus more constricted distally.

Holotype, male, Charleston Mountains, Nevada, May 14, 1934 (Dr. J. A. Comstock) and in the collection of the Los Angeles County Museum.

Allotype, female, Charleston Mountains, Nevada, May 13, 1934 (G. H. and J. L. Sperry) and in the Sperry collection.

Paratypes, 10 males, Bailey Park, Panamint Mountains, Inyo

Co., Calif., July 4, 1940 (Henne); 2 females, data as in holotype, in the Los Angeles County Museum and Sperry collection.

It gives me great pleasure to name this rare species in honor of our friend Mrs. John A. Comstock, who probably captured part of the Nevada series, perhaps most of it, herself, with her husband, our companion on many a gorgeous collecting trip and whose ability to conjure delectable dinners from a camp cookstove is entirely beyond belief. May the time come soon when we may all take the road again together.

This species should be placed after *bifilata* Hulst in the list. The maculation is similar but more obscure and *bifilata* is sexually dimorphic which *ruthiaria* is not. Antennal pectinations are longer than in *monicaria secundaria* and *carnearia* and it lacks the reddish tinges of *lutearia* and *columbiaria;* maculation, size and shape of forewing separate it from all other species in this genus. It is possible that this may be a form of *bifilata,* far removed from the parent stock but this can only be determined by breeding the species.

Among the specimens brought from the Los Angeles County Museum there is a short series of another Drepanulatrix which on careful examination proves apparently undescribed,

DREPANULATRIX RINDGEARIA, n. sp.

Both sexes: Palpi, front, legs, thorax and ground color of forewings, light vinaceous cinnamon (Ridgway color); collar and antennal pectinations brown-black; abdomen and secondaries light cinnamon, maculation of all wings black-brown. Male antennæ bipectinate, pectinations long, apex simple. Female antennæ simple.

Forewing: T.a. line starts from a spot on the costa at 1/4 out from base at right angles to costa, curves evenly through cell then straight to inner margin at 1/3 out from base. There is a wide (1 mm.) median shade starting from an obscure blotch on the costa at just beyond 1/2 going straight across the wing just outside the large, oval, dark discal dot and narrowing to 1/2 mm. in width at the inner margin at 2/3. T.p. line starts at 3/4 out from base curves evenly through the cell to line 3 then straight to inner margin where it touches the outer edge of median shade. The usual line of dark triangular dots appears between the t.p. line and the outer margin, starting about 2 mm. from apex on costa, the line goes subparallel to the t.p. line to inner margin, the dots appearing between the veins. There is a dark dash exactly at the apex, fringes concolorous with the ground color of the wing, the whole wing dusted lightly with dark atoms. Second-

aries: much lighter than the primaries, a median line 7/10 out from the base on inner margin starts at a heavily shaded spot and goes toward the center of the wing, fading out before reaching the cell, there is a start of an outer line in small connected blotches above the angle. The wing is lightly dusted near anal angle and along inner margin with dark brown atoms. A small dark discal dot. Fringes concolorous with wing.

Beneath creamy cinnamon, without maculation, discal dots on both wings showing dimly through. The female tends to be lighter and to have more of an ochreous tinge than does the male, which is often the case in this genus.

The maculation, though lighter, is as distinct as in the male. Expanse, male, 32 to 33 mm.; female, 32 to 34 mm

Holotype male, Round Valley, Inyo Co., Calif., Aug. 10, 1929 and in the collection of the Los Angeles County Museum.

Allotype, female, same data, Aug. 4-6, 1929 and in the Sperry collection.

Paratypes, 4 males, 4 females, same data and in the collection of the Los Angeles County Museum and the Sperry collection.

This species is nearest *hulsti* Dyar but is more heavily and evenly maculated, the outer row of dots parallels the t.p. line on the forewing instead of approaching it as in *hulsti* and the apical dash is usually missing in *hulsti*. The genitalia are very close but the armature of the vesica is lighter in *rindgearia* and the edge is less heavily dentate. The wings of *hulsti* are broad, those of *rindgearia* considerably narrower although the expanse is the same. In an average *hulsti* the distance from apex to anal angle is 13 mm. in *rindgearia* 10 1/2 mm. and the perpendicular distance from anal angle to costa is 11 mm. in *hulsti* and 8 1/2 mm. in *rindgearia*.

Breeding, of course, may find that this is a form of *hulsti* but from our present knowledge of the Drepanulatrix species it would seem to be a good species.

It gives me pleasure to name this species in honor of my friend, Mr. Frederick Rindge, who, I suspect, knows more about this genus than do I, with the hope that he may one day find time to revise it to the profit of us all.

A CHECK LIST OF THE HAPLOTREMATIDAE, TESTACELLIDAE, AND ZONITIDAE OF CALIFORNIA

FROM HENRY A. PILSBRY'S MONOGRAPH

WILLIAM MARCUS INGRAM
Mills College, California

As was, "A Check List of the Helicoid Snails of California", Ingram (1946), this paper is based on Dr. Henry A. Pilsbry's monograph on "The Land Mollusca of North America (North of Mexico)", Pilsbry (1946, vol. 1, pt. 1). This paper should be considered as a companion work to the one published by Ingram (1946), which was based on Pilsbry (1939), (1940). A third paper will appear in this series when part two of volume two of Dr. Pilsbry's monograph is finally published.

Thirteen species and subspecies of Haplotrematidae in the genus *Haplotrema;* one species of Testacellidae in the genus *Testacella,* and eighteen species of Zonitoidea including four species of *Oxychilus,* one species of *Euconulus,* one species of *Retinella,* seven species and subspecies of *Pristiloma,* two species of *Zonitoides,* and one speies each cf *Striatura* and *Vitrina* are reported from California.

Apparently due to the obscurity and the scattered nature of specific records of a number of these species, specific localities are less often cited by Dr. Pilsbry than in volume one, the author often just citing the distribution by counties. Localities are added from the text since not all are included in the distribution section under each species.

SPECIES LIST

FAMILY—HAPLOTREMATIDAE

HAPLOTREMA DURANTI (Newcomb)

Type locality: Santa Barbara Island.

Los Angeles County: Santa Barbara Island.

Santa Barbara County: Santa Cruz Island at Scorpion Harbor, Pelican Bay, Canada del Puerto, and Prisoners Harbor.

HAPLOTREMA DURANTI CONTINENTIS H. B. Baker

Type: 152672 Academy of Natural Sciences, Philadelphia, Pennsylvania.

Type locality: Under rocks in arroyos on slopes of Big Grizzly Peak, back of Berkeley, Alameda County.

Alameda County: See type locality above; hills back of Hayward.
Marin County: Near Lagunitas.

Haplotrema catalinense (Hemphill)
Type locality: Catalina Island.
Los Angeles County: Catalina Island.

Haplotrema caelatum (Mazyck)
Type locality: Santa Barbara, Santa Barbara County.
Alameda County: Hayward.
San Diego County: San Diego.
Los Angeles County: Millard Canyon back of Pasadena; along Los Angeles River near Glendale; near Pasadena.
Santa Barbara County: Santa Barbara.

Haplotrema keepi (Hemphill)
Type locality: Hills near Oakland, Alameda County.
Alameda County: Hills near Oakland.
Mendocino County: One mile west of Cold Creek Fish Hatchery between Blue Lake and Ukiah.
Shasta County: Redding.

Haplotrema transfuga (Hemphill)
Type: Hemphill Collection in the California Academy of Sciences, San Francisco, California.
Type locality: San Diego, San Diego County.
San Diego County: San Diego.

Haplotrema alameda Pilsbry
Type: 82879 Academy of Natural Sciences. Philadelphia, Pennsylvania.
Type locality: Niles Canyon, Alameda County.
Alameda County: Niles Canyon.
Mariposa County: Merced River near El Portal just outside Yosemite Valley.
Contra Costa County: Mt. Diablo.
Calaveras County: Banks of Calaveras River near Jenny Lind.
Tuolumne County: Side of Stanislaus River at Melones in the Mother Lode country.
"Localities for varying forms of *H. alameda* in the interior counties are known from Calaveras to Tulare Counties. It appears that Alameda Co., type locality is a limited western occurrence, rather out of the main range of the species. Until further study of the species throughout its range is made, no sound division into subspecies can be made." Pilsbry (1940).

Haplotrema minimum (Ancey)
Type: A lectotype, 7402 California Academy of Sciences, San Francisco, California.

Type locality: San Francisco, San Francisco County.
San Francisco County: San Francisco.
Marin County: Tomales Bay.
Napa County: Aetna Springs.
Alameda County: Oakland.
No specific localities in the following counties: Sonoma, San Mateo, Santa Cruz, Monterey, San Luis Obispo.

HAPLOTREMA VANCOUVERENSE (Lea)
Type: 425341 United States National Museum, Washington, D. C.
Type locality: Vancouver, Washington County, Washington.
Del Norte County: Lighthouse Isl., and Endert's Beach near Crescent City.
Humboldt County: Six miles above Charlotte; Capetown.

HAPLOTREMA SPORTELLA (Gould)
Humboldt County: Endert's Beach, five miles north of Crescent City and "Klamath" County. (Klamath County is now probably in Humboldt County; see discussion under *H. voyanum humboldtense* Pilsbry).

HAPLOTREMA SPORTELLA HYBRIDUM (Ancey)
Marin County: Bolinas Bay.
No specific localities in Napa and San Mateo Counties; these localities are credited by Pilsbry to a *var. semidescussatum* (Gratacap), and not directly to *H. sportella hybridum* (Ancey) *s.s.*

HAPLOTREMA VOYANUM (Newcomb)
Type: In Newcomb Collection, Cornell University, Ithaca, New York; paratypes 11816 Academy of Natural Sciences, Philadelphia, Pennsylvania.
Type locality: Canyon Creek, Trinity County.
Trinity County: Canyon Creek; small creek entering Stuarts Fork, Trinity River, half mile north of Trinity Alps Camp.
Shasta County: No specific locality.

HAPLOTREMA VOYANUM HUMBOLDTENSE Pilsbry
Type: In Academy of Natural Sciences, Philadelphia, Pennsylvania.
Type locality: "A large form from Humboldt and "Klamath" counties has a somewhat narrower spire than typical *voyanum,* and the striation is strong and coarser." "Klamath" is an extinct county (Nautilus 50:105); the locality of the *Haplotrema* is in what is now Humboldt County. Pilsbry (1946).

FAMILY—TESTACELLIDAE

TESTACELLA HALTOTIDAE Drap.
Alameda County: Berkeley.

FAMILY—ZONITIDAE

EUCONULUS FULVUS ALASKENSIS (Pilsbry)

Type: 59522 Academy of Natural Sciences, Philadelphia, Pennsylvania.

Type locality: Dyea Valley, Alaska.

"In California it is found in places along the western slope of the Sierra Nevada, and as far south as the San Bernardinos." Pilsbry (1946).

OXYCHILUS CELLARIUS (Müller)

San Francisco County: San Francisco.

OXYCHILUS DRAPARNALDI (Beck)

Alameda County: Oakland; Berkeley.
San Francisco County: San Francisco.
San Diego County: San Diego-Balboa Park.

OXYCHILUS ALLIARIUS (Müller)

Alameda County: Oakland.
San Bernardino County: Redlands.
San Francisco County: San Francisco.

OXYCHILUS HELVETICUS (Blum)

Alameda County: Oakland.

RETINELLA BINNEYANA OCCIDENTALIS H. B. Baker

Type: 150605 Academy of Natural Sciences, Philadelphia, Pennsylvania.

Type locality: Along McAleer Creek, near border of King County, just north of Seattle, Washington.

Siskiyou County: Bear Creek and Pavilion Dome.

"In northern California (around Mt. Shasta), a form with the burnished, hyaline shell, the spiral sculpture and genetalia (animals from near Weed, Siskiyou Co.) of *occidentalis* attains a much larger size and actually approaches the dimensions of *electrina.* (H. B. Baker)". Pilsbry (1946, p. 262).

PRISTILOMA LANSINGI (Bland)

Type locality: Astoria, Oregon.

Humboldt County: Endert's Beach and Klamath.

PRISTILOMA NICHOLSONI H. B. Baker

Type: 149978 Academy of Natural Sciences, Philadelphia, Pennsylvania.

Type locality: Under pieces of wood on hillside near spring brook (first small branch below Big Canyon Creek) about two miles south of Lagunitas, Marin County.

Marin County: See Type locality.

PRISTILOMA SHEPARDAE (Hemphill)

Type: A paratype 86664 Academy of Natural Sciences, Philadelphia, Pennsylvania.

Type locality: Santa Catalina Island.
Los Angeles County: Santa Catalina Island.
Santa Barbara County: Santa Cruz Island at Scorpion Harbor.

PRISTILOMA OROTIS (Berry)
Type: 7095 Berry Collection, Redlands, California.
Type locality: Near sawmill on south ridge of Palomar Mountains, east of Palomar resort, San Diego County; in woodsy ravine under fallen logs and bark.
San Diego County: See Type locality.

PRISTILOMA GABRIELINUM (Berry)
Type: 5033 Berry Collection, Redlands, California.
Type locality: Near Camp Estelle, Upper San Antonio Canyon, San Gabriel Mountains, altitude 5100 to 5200 feet.
Los Angeles County: See Type locality; also from Icehouse Canyon, San Gabriel Mountains in a wood rat's nest.

PRISTILOMA CHERSINELLA (Dall)
Type: 109442 United States National Museum, Washington, D. C.
Type locality: Calaveras Big Trees, north group, Calaveras County.
Calaveras County: See Type locality; many places in Calaveras.
Klamath County: Ouxy, east shore Upper Klamath Lake.
No specific localities in the following counties: Mariposa, Mono, Fresno, Tulare.

PRISTILOMA SUBRUPICOLA SPELAEUM (Dall)
"Vitrea" subrupicola var. *spelaea* Dall is known by the following notes only: "It may be mentioned that the original types of *V. subrupicola* were collected at Clinton's Cave, Utah, by Dr. Packard; while much larger specimens, though with the same number of whorls, were collected later at Cave City, Calaveras Co., California, by Hemphill. After careful study I have found no characters except size to separate these from the Utah specimens, but in view of this difference the former may take the varietal name of *spelaea.* Neither form can be confounded with *V. indentata* by anyone who critically compares good specimens. A specimen of *V. subrupicola* with four whorls has a major diameter of 2.7 mm., one of the variety with exactly the same number of whorls, measures 4.0 mm., and my largest specimen is 5.5 mm. (Dall)". Pilsbry (1946).

HAWAIIA MINUSCULA (Binney)
Type: Possibly housed in the Academy of Natural Sciences, Philadelphia, Pennsylvania, numbered 74416. Pilsbry (1946, p. 423).

Type locality: Ohio.

Los Angeles County: San Gabriel Mountains.

San Diego County: Balboa Park; False Bay.

Santa Clara County: San Jose, in greenhouses.

San Bernardino County: Mouth of Mills Creek Canyon, San Bernardino Mountains.

ZONITOIDES NITIDUS (Müller)

San Diego County: San Diego.

Alameda County: University of California campus, Berkeley.

Los Angeles County: No specific locality.

ZONITOIDES ARBOREUS (Say)

No specific localities in the following counties: Calaveras, Los Angeles, Madera, Mariposa, Modoc, Placer, San Bernardino, San Diego, and Siskiyou.

STRIATURA PUGETENSIS (Dall)

Type: 107541 United States National Museum, Washington, D. C.

Type locality: From near Seattle, Washington.

Orange County: San Juan Capistrano Creek.

San Bernardino County: Mountain Home, San Bernardino Mountains.

San Diego County: Palomar Mountains.

No specific localities in the following counties: Alameda, Calaveras, Los Angeles, and Mariposa.

VITRINA ALASKANA Dall

No specific localities in the following counties: Fresno, Inyo, Lassen, Madera, Mariposa, San Bernardino, Siskiyou, Tulare, and Plumas at altitudes from 4000 to 8000 feet.

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FOUR NEW GASTROPODS FROM THE UPPER PLEISTOCENE OF NEWPORT BAY MESA, ORANGE COUNTY, CALIFORNIA

By GEORGE WILLETT*

INTRODUCTION.—Previously reported from the Newport Bay Mesa locality[1] were two pelecypods new to the upper Pleistocene marine fauna of southern California. In addition are four new gastropods from the same locality. These are described below.

Turbonilla (Turbonilla) grouardi sp. nov.

(Plate 4, fig. 1)

DESCRIPTION.—Shell white, slender with sides convergent, the diameter increasing very gradually. Whorls slightly rounded, shouldered; shell constricted at the sutures; ribs vertical or nearly so. Early whorls (about 5) missing from the type. Ribs 12 to 13 on first three of remaining turns, 16 on the next, and 21 on the penultimate. These ribs extend from the summit almost to the succeeding suture, the smooth band at their termination being narrow. Intercostal spaces on penultimate whorl about as wide as on earlier whorls. Base rounded, aperture oval, somewhat extended anteriorly; columella nearly straight.

Type, No. 1069 Los Angeles County Museum, collected by George P. Kanakoff in lower north exposure of upper Pleistocene deposits of Newport Bay Mesa, Orange County, California (L.A.C.M. Invert, Paleo. Loc. 68-B.) An additional example (younger individual), also without nuclear whorls, taken at the same locality. Measurements of the type (exclusive of missing early whorls): length 5.2 mm.; transverse diameter 1.6 mm.

DISCUSSION.—The shape of the whorls in this species is much as in *Turbonilla calvini* Dall and Bartsch, their diameter posteriorly being as great as it is anteriorly. However, *T. grouardi* is much larger than *T. calvini,* and differs further in the abrupt increase in number of ribs on the last whorl. This species is named for Mr. and Mrs. F. L. Grouard, who first reported these deposits to the Museum.

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*Manuscript prepared by Mr. Willett shortly before his death.

[1]Willett, George, Two New West American Pelecypods, So. Calif. Acad. Sci., vol. XLIII, pt. 1, pp. 19-22, pl. 7, 8, 1944.

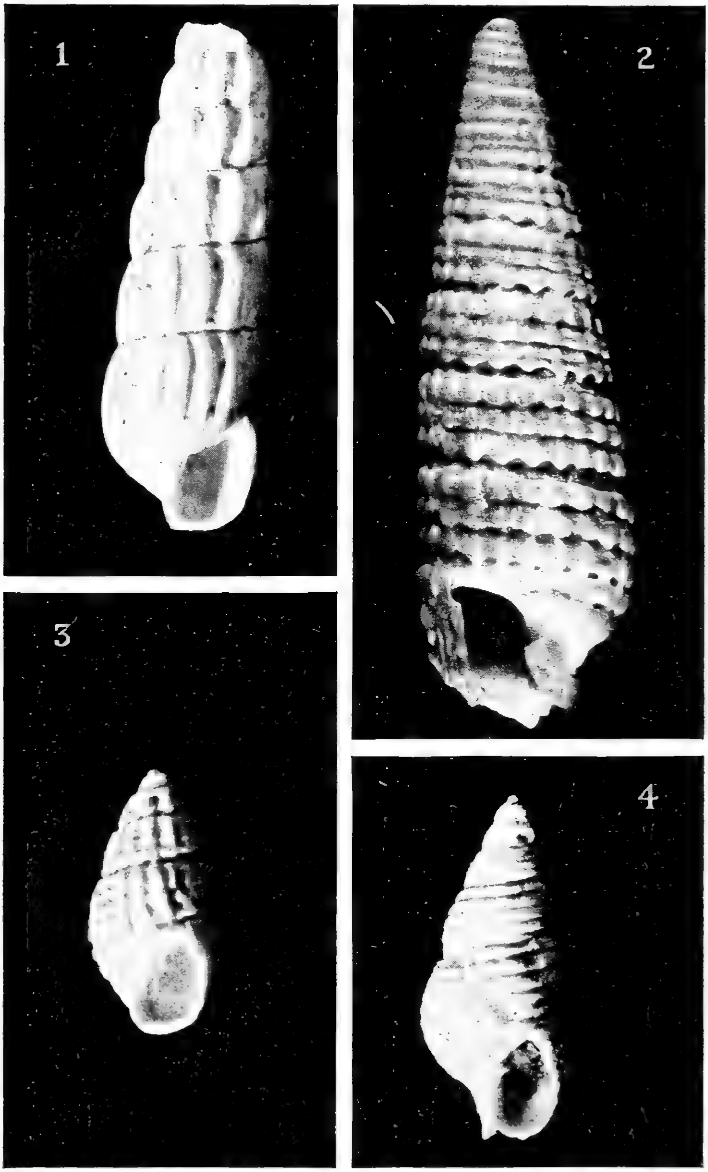


PLATE 4

1. Turbonilla grouardi Willett
2. Triphora kanakoffi Willett
3. Odostomia elsiæ Willett
4. Odostomia effiæ Willett

Odostomia (Menestho) effiæ sp. nov.

(Plate 4, fig. 4)

Description.—Shell imperforate, elongate-conic. Nucleus small, tilted, partly immersed obliquely in succeeding turn. Post-nuclear whorls slightly rounded, ornamented with four heavy, spiral cords, which are more than twice as wide as the grooves separating them. On the last whorl the peripheral arc emerges to form a fifth cord almost as heavy as the four preceding it. Sutures weakly channeled. Base rounded; aperature rounded below, acutely angled above; columella with distinct fold at its insertion. Base with about 8 ribs which grow gradually weaker as they approach the columellar region.

Type, No. 1070 Los Angeles County Museum, collected by George P. Kanakoff at upper north location of upper Pleistocene deposits of Newport Bay Mesa (LACMIP Loc. 63-A). Two additional specimens collected at the same location, and one at Los Angeles County Museum locality 66.

There are also at hand four examples of this species collected by Effie M. Clark and Edna T. Cook at an upper Pleistocene deposit on Vermont Avenue near Sepulveda Blvd. just beyond the city limits of Los Angeles. The type has 6 whorls and measures: length 3.5 mm.; transverse diameter 1.3 mm. A paratype in Mrs. Clark's collection measures 4.0 by 1.6 mm.

This small species is similar in appearance to *Odostomia grammatospira* Dall and Bartsch, from which it differs in smaller size and heavier spirals, with correspondingly much narrower interspaces. It is named for Mrs. Effie M. Clark, who has many interesting species of mollusks in the fossil beds of this region.

Odostomia (Chrysallida) elsiæ sp. nov.

(Plate 4, fig. 3)

Description.—Shell small, elongate-ovate; sutures channeled. Nucleus tilted, partly immersed in succeeding turn. Post-nuclear whorls ornamented with slightly retractive axial ribs running from suture to suture; on the first post-nuclear whorl of the type these ribs are obliterated, the second has 14, the third 16, and the last whorl 20. Spiral sculpture inferior to axial, consisting of three thin, equally spaced threads on the anterior two thirds of the whorl, there being no spiral thread at the summit. Base rounded, marked with four strong, evenly-spaced cords of about equal strength. Aperture oval, angulated above, rounded below, with little, if any, anterior projection; inner lip expanded, covering the umbilicus; columellar fold inconspicuous and only visible well within the aperture.

Type, No. 1071 Los Angeles County Museum, collected with one additional specimen, by George P. Kanakoff, at the upper north location of upper Pleistocene deposits of Newport Bay Mesa, Orange County, California (LACMIP Loc. 68-A). The type has five post-nuclear whorls. Measurements: length 2.7 mm.; transverse diameter 1.3 mm. The paratype is approximately of same length, but shell more slender, probably due to wear.

Although this is a very small species, the writer does not know any other which it resembles closely. It shows some similarity to *Odostomia talama* Dall and Bartsch, but differs markedly from that species in smaller sizes, absence of spiral at the shoulder, and fewer basal cords. This shell is named for Elsie M. (Mrs. T. P.) Chace, whose work on California mullusca is well known.

Triphora kanakoffi sp. nov.

(Plate 4, lg. 2)

DESCRIPTION.—Shell large for genus, sinistral, elongate-conic, brown. Nucleus and first two post-nuclear whorls missing. First two of remaining turns with two spiral rows of nodes, one at the top, the other at the bottom of the whorl; on the next whorl (the 5th) a slender, tuberculated, spiral keel appears about midway between the two marginal rows of tubercles; this keel increases in strength until, on the ninth turn, it is about as strong as the other two; on the last whorl there are four rows of tubercles, the anterior of these being somewhat weaker than the others; also, on the latter part of the last whorl is a median intercalated riblet. On all the turns the anterior row of tubercles, on its anterior side, slopes gently into the suture. Tubercles rounded, connected between the rows, but axial sculpture hardly apparent, always inferior to spiral sculpture. Tubercles numbering 16 on first two remaining turns, increasing to 22 on the penultimate whorl and 25 on the last. Base short, bounded posteriorly by a prominent, smooth cord, followed by two, more obscure ones which are somewhat roughened and broken by lines of growth. Aperture diagonal, oval, extended at both ends, deeply channeled anteriorly; outer lip thin, inner lip expanded over the stout, twisted columella.

The unique type, No. 1072 Los Angeles County Museum, was collected by George P. Kanakoff in the upper Pleistocene deposits on the south side of Newport Bay Mesa, Orange County, California (LACMIP Loc. 66-1). The type has ten remaining whorls. Measurements: length 9.0 mm.; transverse diameter 3.0 mm. A complete specimen of comparable size would measure approximately 9.5 millimeters in length.

In shape and sculpture this shell is similar to *Triphora pedroana* Bartsch, which occurs in the same deposit. It differs from

that species in much larger size, wider sutures, and earlier appearance of the median row of tubercles. In diameter, this is the largest of our known local Triphoras; in length, it is exceeded only by the more slender and very differently ornamented *Triphora callipyrga* Bartsch, which sometimes attains a length of 11 millimeters. The writer takes pleasure in naming this interesting species for George P. Kanakoff, through whose efforts these collections were obtained.

Los Angeles County Museum.

FOSSIL ARTHROPODS OF CALIFORNIA

15. SOME HEMIPTERA FROM THE McKITTRICK ASPHALT FIELD

By W. DWIGHT PIERCE

The great abundance of aquatic Hemiptera in the McKittrick deposit is of interest, especially because many of the insect bodies are more or less intact. These will assist in the determination of the fragments found in the Rancho La Brea Asphalt. As was stated in the preceding article, the writer has dropped the idea of an ancient lake, and is inclined to the theory that these insects were either trapped by alighting on active flowing sheets of shining tar, or by swimming in pools of water lying on top of active liquid tar. That there were at least temporary pools is attested by damsel fly larval remains.

In this and all other studies of tar field insects, it is the writer's purpose to give a new and modern interpretation of the anatomy, using as far as possible the Snodgrass nomenclature. In many ways this will differ from the classical terminology used in the Hemiptera. In this order it has been difficult to find articles dealing with the morphology of parts other than head, wings and genitalia. The paleoentomologist is not always privileged to have these parts. He must classify his fragments, no matter to what part of the skeleton they belong. The heads and thoraces of the water Hemiptera are very interesting, and illustrate great modifications for the purpose of water navigation.

Paleontological research in entomology has only one counterpart, and that is the study of fragments found in bird stomachs,

and in the excreta of birds, mammals, and reptiles. While a great deal of work has been done in this latter field, the workers did not leave any record of their morphological findings.

It is the purpose in the present series to point out those facts that will assist future workers.

The thorax is a dominant part of the remains. Its structure is therefore a criterion for placing the fragment in its order. The primitive orders of insects, belonging to the old grouping Thysanura, have the thoracic segments subequal and non-agglutinate. After the evolution of wings it was necessary to strengthen the thorax and this was accomplished in several ways.

In the first group, the prothorax is independent, and more or less emphasized, and the meso-and metathorax are agglutinate. To this group belong the Mallophaga, Isoptera, Embiida, Corrodentia, Plecoptera, Orthoptera, Phasmida, Blattariae, Mantodea, Hemiptera, Homoptera, Thysanoptera, Dermaptera, Coleoptera, Rhaphidodea, and Neuroptera.

In the second group prothorax is much reduced, and meso-and metathorax are strengthened. Of these, the parts of the thorax are all independent in Aleurodoptera, and Strepsiptera, with the metathorax strongly developed in the latter. In the second section of this group the entire thorax is agglutinate in Odonata and Ephemerida among the hemimetabolous insects; and in the holometabolous insects the mesothorax is dominant with only mesothoracic wings in Diptera and Coccoptera; while the metathorax is dominant in the wingless Siphonaptera, and the winged Mecaptera, Megaloptera, Trichoptera, Lepidoptera, and Hymenoptera. In the last order the first abdominal segment is also agglutinate.

The Hemiptera fragments found in the Bessom material bring out a number of interesting features. The head and prothorax in all five families (Notonectidæ, Corixidæ, Belostomatidæ, Nepidæ, Gerridæ) separate from the meso-metathorax. The heads are very distinctive: head flattened against prothorax and eyes inset in Notonectidæ and Corixidæ; but eyes protuberant in Gerridæ, Nepidæ, and Belostomatidæ. The Corixid head is like a closed disk with only a small opening for attachment to the prothorax; while the Notonectid head is broadly open behind. In the Nepidæ, at least Ranatra, there is a distinct neck, although this is not apparent except on dissection, or when found as in the tar. The Notonectid, Corixid, and Belostomatid pronota extend back as a covering over considerable part of the mesonotum, while the sternal portion is very small. The Nepid thorax as found in Ranatra is a dominant segment, with only the posterior portion extending over the mesonotum; the front legs are almost adjacent to the tiny head, and the bulk of the prothorax extends far to the rear. In the Gerridæ an unusual feature results from the union

of the mesonotum with the prothoracic ring, so that the cleavage line separates almost all the mesothoracic covering. Finding an elongate meso-metathoracic shell with the dorsum missing is a clue to its position in the Gerridæ. This feature and the broader separation of metathoracic coxæ separates the thoraces of *Gerris* from *Ranatra*.

The present paper contains the studies only of the Notonectidæ and Nepidæ. The others will follow in a later contribution.

FAMILY NOTONECTIDÆ

The back swimmers of the family Notonectidæ were present in great numbers at McKittrick, but careful study of the fragments from the 4 foot level at Site 4 indicates only one species belonging to the subgenus *Paranecta,* genus *Notonecta.* From the numerous fragments, almost all of the characters of the species can be elucidated. In fact a number of specimens were almost complete.

These insects are called back swimmers because they swim at the surface with the venter up. They inhabit ponds, lakes, and stagnant pools. They are predaceous upon other insects, grasping their prey with the front legs while they suck the blood. The hind legs are used as oars.

Fortunately there is a beautiful monograph of the genus *Notonecta* for the World by Dr. H. B. Hungerford (Bull. Univ. Kans. 34 (5):1-195,17 plates (5 colored)).1933), and by study of this and the modern insects in the collection of the Los Angeles County Museum, I have determined that the insects from the 4 foot level of Site 4, McKittrick, are a new species.

It may be stated at this time that the genus *Notonecta* was also present in the Los Angeles La Brea deposits, but the material is more fragmentary and must be reported on later. It is unquestionably Pleistocene, because all of the recovered fragments come from the skull cavities of saber-tooth cats, found in Pits 3, 4, and 13.

The material upon which the following description is based includes more or less whole insects numbered McK 7a (holotype), McK 7b (paratype used in illustration), and McK 7g (male allotype); head and thorax, McK 7f; heads McK 7c, d, e. I have set aside under McK 7 as paratypes without letter, 9 bodies with head; one separated head and pronotum; 16 large body fragments without head; 12 wings, and 15 wing fragments (all unicolorous). The 7 heads included all measure 2.24 mm. width as in type. Only head McK 7e is larger, measuring 2.32 mm. Over 65 fragments

of Notonecta, all apparently of this species, were not used in the description, but are by virtue of their source all parts of the topotype series.

NOTONECTA (PARANECTA) BADIA, new species (Figures 4-9)

McKittrick, California, asphalt field, collected August 10, 1947 by Leonard Bessom, at depth of 4 feet in asphalt permeated silt.

Holotype Female (McK 7a): length 8.80 mm.; length of head 0.880 mm., prothorax 1.840 mm., scutellum 1.760 mm., inner line of clavus from scutellum to apex 2.160 mm. Width of head 2.34 mm., vertex in front 1.040 mm., synthlipsis 0.408 mm., thorax at base 2.960 mm., scutellum 2.560 mm.

Color very dark reddish brown or maroon; eyes, and scutellum black. It is believed that these are very close to the original colors, as in our experience insect colors are preserxed by tar. The wings are very dark, brown at base, becoming almost black at tip, but without any spotting. (Three spotted wings are being held for association with body fragments.)

The species runs in Hungerford's key near to *N. spinosa* Hungerford, and *N. unifasciata* Guérin, from both of which it differs by the coloration of the wings, and the male genital capsule.

Anterior margin of head with vertex slightly more convex than eyes; width of vertex to synthlipsis (distance between eyes at base) as 13:6 (Fig. 4). Face without any definite frontoclypeal demarkation (Fig. 5), except for a slightly raised clypeal zone almost reversing the shape of the labrum, which is broad at base, suddenly concavely narrowed, so that the base is to the apex as 14:3, roughly the form of a squat T. Beak with three joints beyond the labrum, of which the second and third are subequal and longer than the first.

Prothorax widening from apex to basal angles; with base strongly rounded; length to width as 23:38. Scutellum triangular, somewhat tapered toward apex, width to length as 32:22, base concave.

Female abdomen (Fig. 7) with fourth sternite wider at apex than the quadrate fifth, which is narrower at apex than the base of the sixth; sixth subtruncate at apex; its exact outline indeterminate. In *undulata,* which it most approaches in abdominal form the fourth sternite is narrower at apex than the base of the fifth.

The mesotrochanter has the outer angle produced and the mesofemur is spined near apex. The drawing (Fig. 6) of this area is from specimen McK 7b.

The male capsule (Figs. 8, 9) was extracted from specimen

McK 7g. It measured 1.52 mm. in length and 0.8 mm in depth. It might be described as a shell of a boat with two seats, the front seat being the 9th and 10th tergites, and the rear seat the cross bar of the aedeagus; behind which the claspers serve as rudders. The frame work is solid beneath with three upward processes on each side, and constitutes as a whole the sternite IX; the anterior processes are united by a non-chitinous band of tergite X; the median processes are broader and approach more closely, but are not united; the posterior processes are separated by a posterior cleavage and bend forward reaching to the median lobes. In the curve between the median lobe and the posterior clasper is an appendage called the harpagone. Within this capsule are the tenth or anal segment, which was not in good shape to study; and the aedeagus, of which a double longitudinal bar, and a basal cross-bar are visible. In shape this capsule differs from all figured by Hungerford.

FAMILY NEPIDÆ

Insects of this family are quite rare in California, only one species of the genus *Ranatra* being reported, *R. brevicollis* Montandon, of which specimens are at hand from Los Angeles, and Claremont in Los Angeles County, and Santa Ana in Orange County. It was described from San Diego, and Hungerford reports it from El Dorado County; Lindsay (Tulare Co.), and Laguna Beach (Orange Co.).

It is therefore of considerable interest to report that at some distant period *Ranatra* of two species occurred in the now very dry country around McKittrick in the western foothills of Kern County.

In fact there are now at hand parts of 7 or at most 8 individuals, one head by itself, two thoraces with head, one thorax and abdomen without head, and three pronota. They are not all in fit condition for description and only three enter the description of *R. bessomi,* and one the description of *R. asphalti.*

The proportionate measurements vary greatly and it is possible that the genus was in great flux at the time this asphalt was laid down.

To show the variation the measurements of all specimens are given:

As a basis for the study we have Dr. H. B. Hungerford's excellent monograph of the Nepidæ of North America (1922. Kansas Univ. Sci. Bull. 14 (18):425-470, 8 plates). In the material at hand there are no legs other than front coxæ and no genitalia, but all other characters used in the genus are available for study.

MEASUREMENTS OF RANATRA FRAGMENTS IN MILLIMETERS

Specimen	McK 11c	McK 11a	McK 11b	McK 11f	McK 11d	McK 11e	McK 12a
Species	R. bessomi holotype	R. bessomi paratype	R. bessomi paratype	R. bessomi paratype	R.	R.	R. asphalti holotype
Entire length	mm. 28.0	mm.	mm.	mm.	mm.	mm.	mm.
Head complete		2.0					
Head visible				1.84			1.6
Pronotum	6.88				7.44	6.60	7.04
Pronotum to slit	4.28		4.96	4.80	4.76	4.44	4.12
Abdomen	15.80						
Prosternum	5.80		6.80		6.00	5.32	5.80
Mesosternum	2.68						2.80
Metasternum	1.48						1.92
Width head				2.72			2.12
Pronotum at apex	1.80		2.00	2.40	2.04	1.84	1.88
Pronotum narrowest	1.36		1.44	1.80	1.64	1.40	1.60
Pronotum at slit	1.80			2.20	2.08		1.80
Pronotum at base	3.04		2.16		3.60	2.80	3.20

Judging from the modern species at hand as well as the fossils, the relationship of the length of bucculæ to tylus (Figs. 10, 11, 13) is a good character. The sternal arrangement especially, in length of metaxyphus, and the presence (Fig. 19), or absence (Fig. 18) of delineation of the trochantin is of interest.

The writer has not found mention of the mesothoracic spiracles, which are at the edge of the prothorax, at base of mesoepisternum (Fig. 18), while the abdominal spiracles are on the pleurites of the segments.

Snodgrass (1947. The insect cranium and the "epicranial suture." Smithson, Misc. Coll. 107(7):1-52, 15 figs.) calls atten-

tion to the suture which defines the fronto-clypeal area. Hungerford in his illustration of the head of Ranatra does not indicate the existence of this suture, although it is distinct in all the specimens, modern and fossil, at hand. It is shown in Figures 10, 11, 13.

For the purpose of comparison Figure 10 illustrates the head of *R. brevicollis* as seen from above. This head is considerably larger than in either of the fossil species.

RANATRA BESSOMI, new species (Figures 11, 12, 16, 17, 18)

Described from one head (McK 11a), one headless body (McK 11c), one prothorax and head (McK 11f), three prothoraces (McK 11b, d, e) from Site 4, depth 4 feet, Leonard Bessom, collector of matrix.

Measurements of head: length as a whole 2.0 mm.; breadth 2.4 mm. The head (Figures 11, 12) is described from paratype McK 11a. By an unfortunate accident this delicate fragment broke into two parts just after completion of the drawings and is mounted in two cells on a slide. The head is slightly wider than long. The beak is missing. The antenna of the right side is present (Fig. 12), and is of the type of *R. nigra* Herrich-Schaeffer, an eastern species, and quite distinct from *R. brevicollis* Montandon, the only California species, which has a long lateral branch to the second segment, about half as long as the third segment. The antenna is three-segmented, the third joint cylindrical, tapering to apex, longer than either of the two preceding; second joint much enlarged on the inner side rather than on the outer side as in other species.

Head (Fig. 11) roughly cross-shaped, with axis of eyes at right angles to axis of head; eyes separated by more than their transverse width, which separates the species from *R. drakei* Hungerford. The epicranial suture or cleavage suture of Snodgrass separates the basal or occipital area medianly. In front of the faint line differentiating two surface sculptures the epicranial suture divides to form a broad ogival frontoclypeal area. This is longer than the eye stalks. The zone behind the eyes, and the narrow band enclosing the eyes is the parietal area. The frontoclypeus is called vertex in most Hemipterous literature, but the true vertex is only the narrow median part of the parietals. The anterior portion of the frontoclypeus is three lobed, with tylus in middle and juga at its sides. In front of the juga are the appendages called bucculæ, not extending forward beyond the tylus, as they do in *nigra,* and *brevicollis*. The juga have a dorsal line of punctures. The entire surface of frontoclypeus is minutely granulate, but this denuded condition is rarely seen in live freshly collected material.

Ventrally (Fig. 12) the eyes are much narrower than dorsally. The longitudinal axis is occupied by the strongly convex gular-submental column, which is basally deeply excavated. The arcuate postoccipital zone is indistinctly indicated and inserted in the convex true gula. This is laterally defined by distinct longitudinal sutures extending to the transverse depression bounding the occipital area from the genal area. In front of this depression the gular zone is more convex and narrower, and may be considered as submental in character, with the anterior narrowed portion between the bucculæ construed as mentum. The bucculæ are subacute at tip. The ventral genal area is quite broad, deeply depressed at sides of gula-submentum, the deepest part of the depression probably corresponding to the tentorial pits. At each side of the submentum are the jugal lobes, behind which are the attachments of the antennæ. These lie in the deep depression of the genæ at the sides of the submentum. Between base of eye and jugum is a deep depression cutting each gena, the continuation of the epicranial suture.

Prothorax (McK 11c) length dorsally 6.88 mm., to slit 4.28 mm., ventrally 5.80 mm.; width at apex dorsally 1.80 mm., at narrowest point 1.36 mm., at slit 1.80 mm., at widest point before base 3.04 mm. The narrowest point is at the middle of the dorsum. The tergum folds over the sides and a good part of the venter bounding the narrow sternum. The basisternite (Fig. 16), or area in front of the coxæ, has a low median longitudinal convexity; is quadrate and narrowly separated from the infolded tergum laterally by a narrow impressed episternal-epimeral piece to which the coxa is attached. The coxa swings forward in this groove. The sternum continues behind the coxal attachment in a narrowing band, which we may call sternellum. This is slightly convex, narrowly impressed at sides, by which character it resembles *R. kirkaldyi, R. nigra,* and *R. brevicollis,* and strongly differs from *R. buenoi.* The coxæ of this genus have only a pivotal attachment, and are very elongate, being 5.6 mm. long, with terminal attachment for trochanter.

Length of body exclusive of head 26 mm. (McK 11c, holotype) thus making total length of body about 28 mm. The mesonotum is covered by the extension of the pronotum, but the mesosternum (Fig. 17) is broad in front and narrowed between the coxæ, at the apex of which it is indistinctly truncate. The anterior part is the basisternite and is medianly impressed. The coxæ are subspherical, with broad round attachment to the cylindrically raised episternum-epimeron. From the lateral view (Fig. 18) the epimeral piece is clearly seen. At the base of the episternum is the broadly elliptical mesothoracic spiracle at the lower edge of two small pieces which must be considered epipleurites. The broad median plate of the metasternum is indistinctly sep-

arated from mesosternum. This is the metaxyphus, which is slightly raised above surrounding parts and narrows into a short prominence barely passing the base of the coxæ, by which it differs from *nigra* and *brevicollis.* At the sides of the basal portion of metaxyphus are two narrow lateropleurites. Extending from the mesoepipleurites to the abdomen is a large metæpipleurite outside the subcylindrical episternum, on which can be seen indistinctly the outline of the epimeron. The trochantin is not separated from sternellum as in *asphalti.*

The abdomen is long and slender and ventrally composed of five long segments, sharply angulate to the middle, with pleuræ depressed. The overfolded tergites slightly surpass the corresponding sternites. Segments 2, 3, 4 bear round spiracles on the tergo-pleural margins each at about the anterior third. The last segment (male) tapers convexly to a point, thus having an ogival pyramidal aspect. On the median line the relative lengths of the segments is 40, 44, 43, 40, 32. The cerci are lacking.

RANATRA ASPHALTI, new species (Figs. 13, 14, 15, 19)

Described from one specimen (McK 12a) from the McKittrick asphalt field, Site 4, depth 4 feet. This specimen has head, thorax and basal portion of abdomen, without legs. The beak separated and is mounted in a cell on a slide.

Length of head as visible 1.6 mm., width 2.12 mm. Length of prothorax on median line 7.04 mm., to transverse crease 4.12 mm., prosternum 5.80 mm., mesosternum 2.80 mm., metasternum 1.92 mm. Width of prothorax at base 1.88 mm., at narrowest point 1.60 mm., at transverse crease 1.80 mm., at widest basal point 3.20 mm.

The head (Figures 13, 14) is considerably smaller than in *bessomi* or *brevicollis.* The bucculæ slightly surpass the tylus. The beak (Fig. 15) is 3-jointed, with the basal joint laterally constricted at the middle. The epicranial suture is sharply defined. The antennæ are biramous, the branch of the second segment terminating opposite the tip of the third. The mentum is short and sharply defined; submental column with sides parallel.

The mesosternum is as in *bessomi,* but the mesasternum is quite different and gives an excellent study of structure. One coxa is missing, showing that the coxal cavity is open behind The metaxyphus is broadly attached to the mesosternum between the mesocoxæ, gradually broadens to a point just before the metacoxæ, and then sharply narrows to a long process reaching to the posterior fourth of the coxæ. It is bordered in its broader portion by narrow strips, which may be called laterosternites; and in the posterior half by curved pieces which extend from the anterior to the posterior attachments of the coxæ, and are hence to

be considered as the trochantins. The tip of metaxyphus lies over the broader sternellum. The posterior epimeron is not well differentiated from episternum.

DESCRIPTION OF FIGURES

PLATE 5

FIG. 4. Dorsal view of *Notonecta badia* Pierce, length 9.35 mm., from McKittrick, Site 4, depth 4 ft.

FIG. 5. Face of *Notonecta bodia* Pierce.

FIG. 6. Middle legs of *Notonecta badia* Pierce, C—coxa, Em—epimeron, Es—episternum, F—femur, SII, III—sternites, Sp—spine, Tr—trochanter.

FIG. 7. Posterior legs and abdomen of *Notonecta badia* Pierce. F—femur, Mc—metacoxa, Mx—metaxyphus, PI, II, III, IV, V, VI—pleurites, S IV, V, VI—sternites, Tr—trochanter.

FIG. 8. Lateral view of male genital capsule of *Notonecta badia* Pierce, Ae—ædeagus, Cl—clasper, Ha—harpagone, S IX—sternite IX, TX—tergite X.

FIG. 9. Dorsal view of male genital capsule of *Notonecta badia* Pierce. Ae—ædeagus, Cl—clasper, Ha—harpagone, T IX, X—tergites.

PLATE 6

FIG. 10. Dorsal view of head of *Ranatra brevicollis* Montandon from Los Angeles. B—buccula, J—jugum, T—tylus.

FIG. 11. Dorsal view of head of *Ranatra bessomi* Pierce, from McKittrick Site 4, depth 4 ft., B—buccula, ES—epicranial suture, FC—frontoclypeus, J—jugum, Oc—occiput, Pa—parietal, T—tylus.

FIG. 12. Ventral view of head of *Ranatra bessomi* Pierce. A—antenna, AS—antennal socket, B—buccula, Ge—gena, Gu—gula, J—jugum, M—mentum, Oc—occiput, Poc—postocciput, Sm—submentum.

FIG. 13. Dorsal view of head of *Ranatra asphalti* from McKittrick Site 4, depth 4 ft.

FIG. 14. Ventral view of head of *Ranatra asphalti* Pierce.

FIG. 15. Lateral view of beak of *Ranatra asphalti* Pierce.

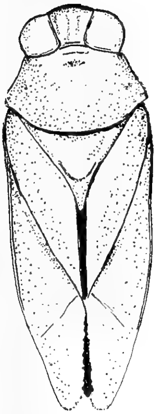
PLATE 7

FIG. 16. Ventral view of prothorax of *Ranatra bessomi* Pierce. BS—basisternite, C—coxa I, Es—episternum, Sl—sternellum, T—tergite I.

FIG. 17. Ventral view of meso- and metathorax of *Ranatra bessomi* Pierce, CC—coxæ, Ep—epipleurite, Es—episterna, Mx—metaxyphus, Pl—pleurite, S—sternite, Sl—sternellum, Sp—mesospiracle, T— trochanter.

FIG. 18. Lateral view of meso-metathorax of *Ranatra bessomi* Pierce. BS—masisternite, C—coxa, Em—epimeron, Ep—epipleurite, Es—episternum, Ls—laterosternite, Mx—metaxyphus, S—sternite, Sl—sternellum, Sp—mesospirac, W—wing.

FIG. 19. Ventral view of metasternum of *Ranatra asphalti*, at double the scale used for Fig. 17, Cx—coxa, Em—epimeron, Ep—epipleurite, Es—episternum, Ls—laterosternite, Mx—metaxyphus, Sl—sternellum, Tn—trochantin.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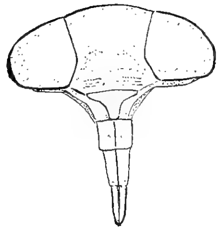
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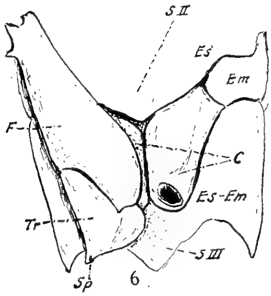

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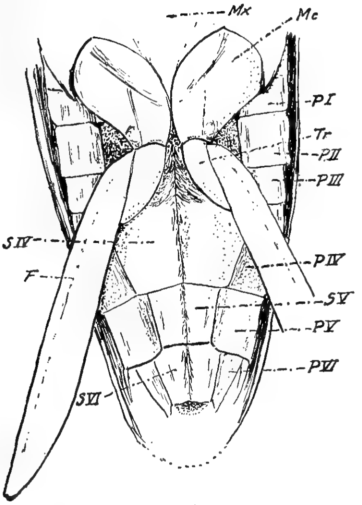

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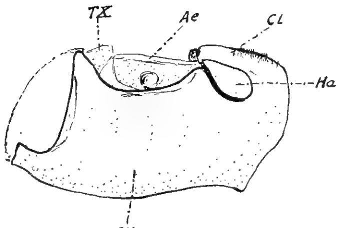

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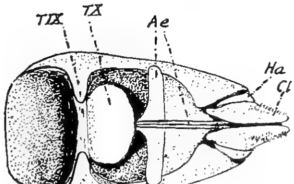

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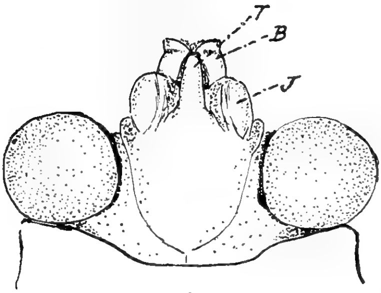
PLATE 5



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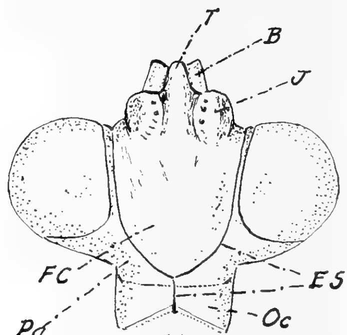

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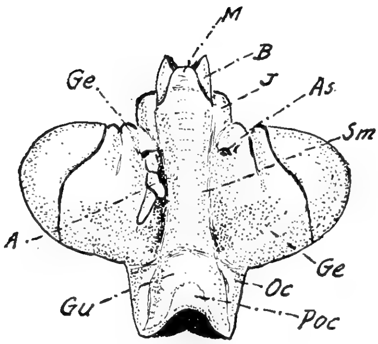

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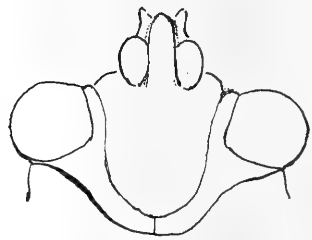

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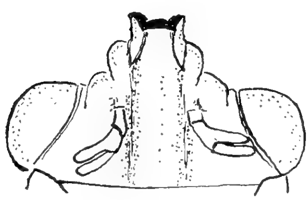

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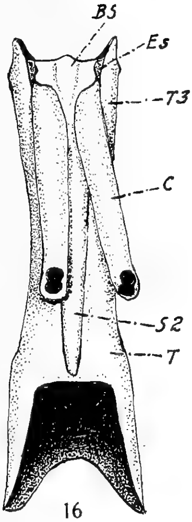
PLATE 6



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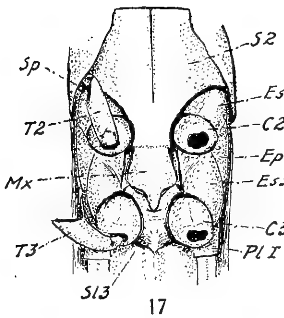

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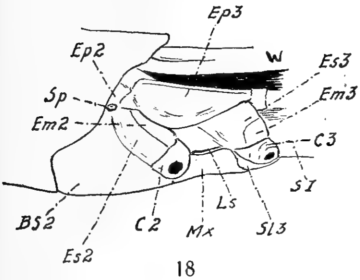

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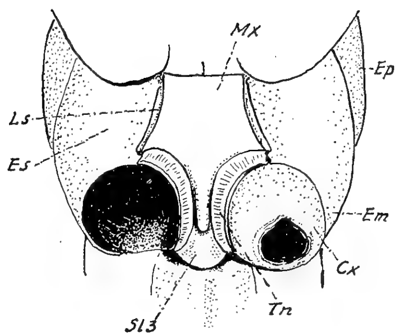

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PLATE 7

FOSSIL ARTHROPODS FROM BRITISH COLUMBIA

By W. DWIGHT PIERCE

1. INTRODUCTION

The present series of studies is designed to present the findings of Walter MacKay Draycot, of Lynn Creek, British Columbia. He has sent to the writer for study several collections of pieces of fossil interglacial lignite (Pleistocene), containing insect remains from two localities.

The first locality was originally found by Rev. Mr. Robert Connell years ago on the shore of Cordova Bay, Vancouver Island, and the first insects from the deposit were described by T. D. A. Cockerell in Canadian Entomologist 59:303-304, as *Donacia connelli* Cockerell, and *D. pompatica* Scudder.

Mr. Draycot visited this site with Mr. Connell in 1945.

Cockerell described the material as a "black lignite from the south end of Cordova Bay, Victoria. The deposit is overlain by 180 feet of clay, sand and gravel called the Cordova sands and gravels and the Maywood clays, the latter the older and both are known to be interglacial. Just above the lignite is a bed of marine shells, and below are finely stratified clays. The lignite contains pieces of wood, seeds, and other plant remains."

Cockerell discussed only the *Donacia* material but said that there were "also a few small black elytra which I have not attempted to determine."

Mr. Draycot wrote October 23, 1946 that to get to the deposit he had to take from Victoria, "the hourly-service bus to a point a mile from Cordova Bay deposits, climb down a steep bank, 180 feet high—and hope for the tide being out when I arrived." His description of the geology is to be found in the following paper.

The second locality is on the Mainland on the banks of Lynn Creek, near the post office of that name, outside of Vancouver; and the geology of the deposits is reported on by Mr. Draycot in the second article of this series.

The material he has sent is very interesting, and will have to be reported on in sections. The botanical material will be studied by paleobotanists. Most of the insect fragments are beetle elytra, some of them so perfect that, by careful work under a binocular microscope, they can be completely freed and mounted in a glass cell for study on both surfaces. Others are badly crushed and must be mounted in cells in the matrix. This crushing is particularly

true of the Donacia material, which still retains its beautiful blue or green lustre.

In all there are 7 insect specimens from Cordova Bay, and 103 specimens from Lynn Creek. Of these some are of course unrecognizable, but there is part of an *Elaphrus* elytron, an elytral fragment of a *Phellopsis,* possibly *porcata* Leconte, many *Donacia,* and several species of small beetles, Lepidopterous pupal remains, and the beautiful psyllid wing described in Article 3. Twelve or more perfect elytra have been separated, and one head.

It is not always easy to locate the classification of elytra, and some of these may need to wait until the study of the California tar deposits gives the cues.

2. PLEISTOCENE FOSSIL BEETLE AND VEGETAL REMAINS IN INTERGLACIAL DEPOSITS; A SUMMARY REPORT

By WALTER MACKAY DRAYCOT

The occurrence of vegetal remains belonging to the Interglacial Period of the Ice Age is recorded mainly along the coastal region of British Columbia. The exposures are meagre; mostly accumulated drift, and gradually disappearing through the effect of river and marine erosional action. In the Greater Vancouver area there are the Lynn Creek Series (situated five miles north of Vancouver City), a shoreline deposit at Point Grey (Vancouver west), and the Cordova Bay Series of Interglacial deposits on the southeastern shoreline of Vancouver Island.

SUMMARY OF PLEISTOCENE

Glaciation of Southern British Columbia and the State of Washington, U. S. A. occurred in the form of two major epochs, the first known as the Admiralty epoch and the second, and last, the Vashon. Both epochs were southern extensions of the great Cordilleran ice sheet that spread over northern and central British Columbia. The names Admiralty and Vashon denote an Inlet and an Island, respectively, in the State of Washington where the two separate glaciation deposits were first noticed by American geologists.

Though retreats and re-advances occurred during the two epochs these phases of minor interglacial periods are insignificant, inasmuch as their duration was too brief to permit vegetation, other than grasses and sedges, to flourish.

ADVENT OF THE ADMIRALTY GLACIER: At the time the Admiralty ice-sheet was forming the land was much lower, relative to sea-level, than now. As the crystallized mass transformed from névé to glacier it culminated in an estimated height of 5,000 feet. This ponderous weight of solid ice, besides depressing the land, had the effect of pulverizing the sub-ice rock material over which it steadily flowed, mainly southwesterly, far into the state of Washington, Puget Sound and the Strait of Georgia. Infraglacial rock fragments, composed of small boulders, pebbles and finer detritus, the result of earlier avalanches or snowslides, were carried hundreds of miles from the source of origin.

DURATION OF ADMIRALTY ICE: Compilation in number of years for the existence of either this first epoch or the last one must ever remain approximate. It can not be definitely known what length of time climatic conditions remained stationary during maximum frigidity.

RETREAT OF THE FIRST ICE EPOCH: As many thousands of years (kalandar) had elapsed since the advent of the ice so thousands more were required to melt the gigantic ice mass in Washington State and British Columbia's southern area. As the melt proceeded the run-off from above and below the ice formed great glacial lakes. Far into these lakes spread the fine silts, known as blue clay, and, nearer the ice front, the fine to course sands pebbles and small boulders. Toward the close of the Admiralty ice epoch the great glacial lakes dwindled in size. Marine waters entered, into which rivers of mostly new channels debouched.

INTERGLACIAL PERIOD IN LYNN VALLEY

Through the visitation of colossal ice conditions the terrain of superficial deposits assumed a barren aspect. A semi-frigid climate obtained for a considerable span of time before the ice had receded far enough into the mountain recesses to permit the hardiest of the lower order of plant life to germinate its seed. Though this was especially the case in the north Burrard region it was not so with the more open terrain of the Cordova Bay area on Vancouver Island, where favorable climatic conditions, close proximity to marine water and far removed from the chilled air of mountain glaciers, induced prior vegetal growth. In some respects the Point Grey shoreline vegetation, somewhat removed from the retreated glacier, enjoyed a similar climate.

DURATION OF INTERGLACIAL: Judging by the stratigraphy of the Interglacial deposits there is evidence of a vast period of time; necessary to deposit the thousands of alternating beds of silt, clay, sand, gravel pebbles and small boulders. A fertile floor for inducement of plant growth.

VEGETAL GROWTH: Continuity of plant life was established in the Great Interglacial Period only during the second half of its existence, although there is evidence of grass growth during a brief withdrawal of the Admiralty glacier, indicated by the presence of brown clay. This was a midway phase during the formation of the glacier.

During the period of continued vegetal growth a minor climatic oscillation occurred when, in the Upper Lynn Series, a slight re-advance and subsequent retreat of a lobe of the adjacent glacier, entrenched in the mountain region, caused blue clay silt to become deposited upon the bed of the first growth vegetation. This is evidenced by the alignment of fallen trees and shrubs in a southerly direction. Vegetal growth resumed, by re-afforestation from untouched localities, when this minor form of glaciation was eliminated from the immediate area.

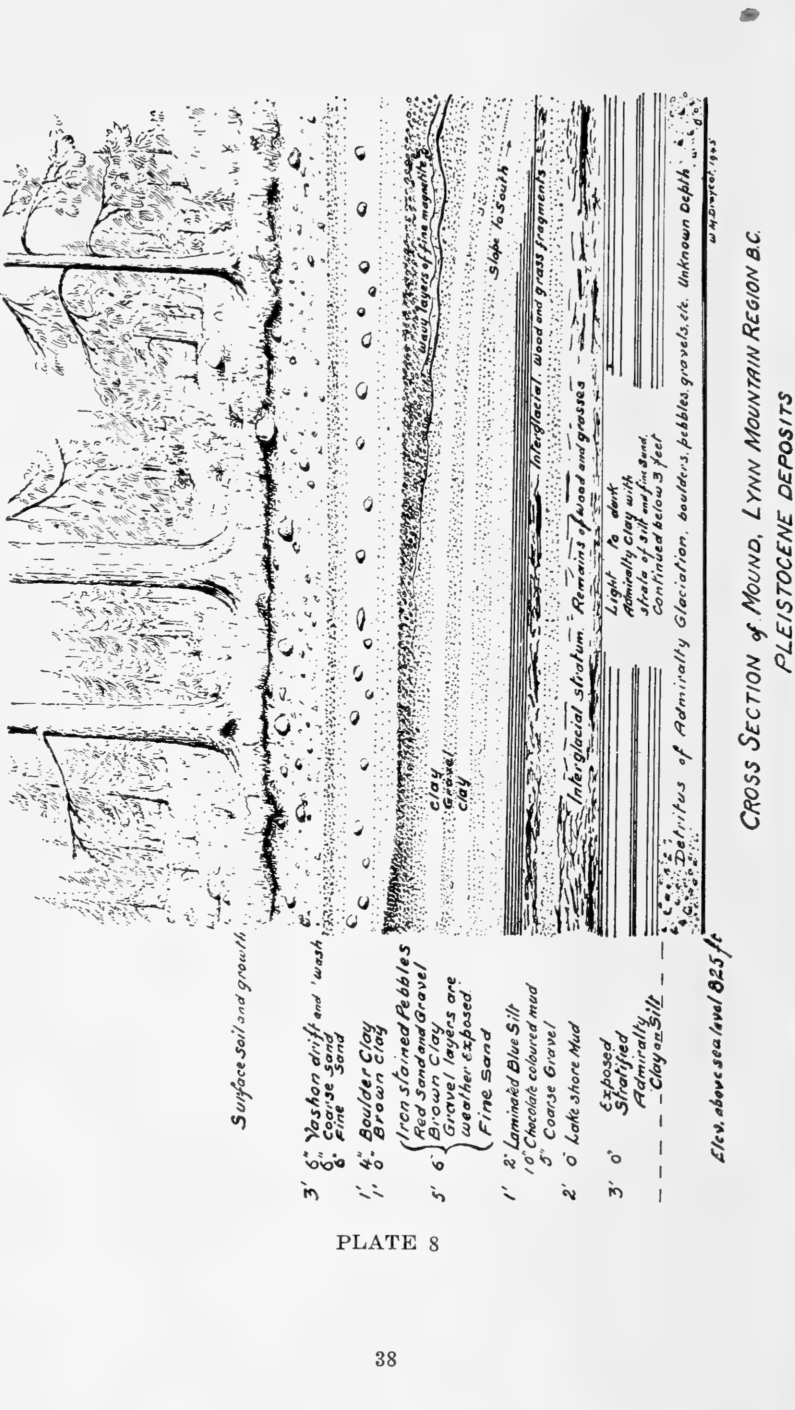
The exposures of Pleistocene deposits in the mountain region of the Lynn river exhibit a series that form a reliable basis for comparison in other sections of southern B. C., which are, in the main, composed of drift material. An isolated deposit at Point Grey being an exception.

Only after thousands of years had passed by, necessary to reduce the bulk of the great ice sheet, did local climatic conditions change to a temperature conducive to the production of a green incrustation composed of the earliest germination of some minute moss and lichen in favored areas. As the mosses and grasses decayed their mould accumulated to form a soil for the reception of the like and diminutive plants. Ferns, herbaceous plants, shrubs and trees followed in sequence. Bogs, swamp and marsh lands prevailed long before the advent of tree growth.

Pondering over the existence of a forest-marsh growth the thought occurred to the writer that Nature, in her scheme of living things, had included other forms of life in conjunction with vegetation. With such a variety of plants, bushes and trees there must be insects of some kind to pollinate and perform other functions; for not all pollination is done by winds.

FOSSIL INSECTS: Small wavy grooves and frass accumulations appearing on the surface of the wood under the bark of spruce and poplar logs and branches, first drew attention of the writer to the past existence of beetles in the Interglacial vegetal remains. The effect was there, but to find the cause! Only beetle *elytra* of the Order Coleoptera was anticipated.

Examination of samples taken from various sections of the vegetal remains resulted in finding several specimens of the brilliant-hued *Donacia* and, later, other specimens. As expert au-



CROSS SECTION of MOUND, LYNN MOUNTAIN REGION B.C.
PLEISTOCENE DEPOSITS

PLATE 8

thority was a factor in distinguishing the specimens they were despatched to the State University of California, to be later transferred to a prominent expert in entomology, Dr. W. Dwight Pierce of the Los Angeles County Museum, who is now proceeding with their classification.

NATURE OF THE INTERGLACIAL FLORA: The thickest deposit of Interglacial vegetal matter occurs in Lynn Valley Park, composed mainly of drift material. Prior to the disastrous landslide of November 14, 1919 the thickness was 12 feet and occupied several acres. Its extent is now measured in feet!

A heavy burden of Vashon (last ice epoch) detritus has pressed the vegetal material into laminated compactness. In the year 1916 the black to brown-black matrix attracted the attention of two prospectors. They excavated a tunnel 100 feet into the mass in the hope of finding coal! There is now no vestige of either tunnel or material; a cloudburst and landslide swept the area clean.

Logs and branches of trees in the matrix have a somewhat flattened appearance. This peculiarity can be readily understood when considering the weight of the massive bulk of glacial till, immense boulders of the Vashon glaciation and, additional, for a great length of time, the overburden of a glacier which for each 1,000 vertical feet there was 50,000 pounds of pressure to the square foot (Prof. Dana).

Species of *Populus* formed the major tree growth; others, in order of succession, as found, are cedar, willow, alder, spruce, birch, and a species of yew. Among the bush plants the blueberry (*Vaccinium*) and hardhack (*Spiræa*) held sway. Among sedges and grasses, in the matrix, the age-old *Equisetum* (Horse-tail) occurs. Considerable of the twigs and small tree branches have become lignified. Taken collectively this assemblage of plant life suggests a climate similar to that now obtaining in this coastal area of British Columbia.

PLEISTOCENE FOREST-BUSH FIRES: In three localities of the North Burrard area where Interglacial vegetal matter is exposed there is evidence of conflagration having spread over an extensive tract. Charred members of tree limbs and well-burned logs imbedded in black hardened mud compose a lower stratum of the shaly vegetal deposit. Angular-shaped rock fragments underlying the burned material are the result of great heat, thus altering the feldspars of the granite to render the fragments friable.

As to the origin of the fire there are two possibilities. If not through the agency of lightning then the cause can be attributed to volcanic ejectamenta from the now extinct Garibaldi volcano

a few miles to the north. The occurrence of volcanic ash and cinders in the Pleistocene deposits, in places intermingled with the vegetation, suggests that origin.

With much of the area being swamp or marsh land the plant growth did not suffer total extinction, as evidenced by subsequent production. The great Interglacial Period, as distinguished from lesser interglacial phases, is the time assigned to the growth of this vegetation, whose scant remnants are exposed in places along the banks of the Lynn Seymour and Thames and Hastings streams. The deposits are overlain by varying thicknesses of Vashon glaciation drift and outwash.

INTERGLACIAL VEGETAL DEPOSITS FROM CORDOVA BAY, VANCOUVER IS., B. C.

About 70 miles west of North Burrard (Inlet) another exposure of Interglacial vegetal deposits occurs at the south end of Cordova Bay, near Victoria, Vancouver Island.

Desiring to correlate these deposits with the Upper Lynn Series a visit was made by the writer, accompanied by the Ven. Archdeacon R. Connell of Victoria, in September, 1945. The vegetal deposit at Cordova Bay is exposed a few feet above high-water mark at the base of a cliff, 200 feet high, and although the formation appears to be *in situ* it is suggested its present position is the result of an almost vertical drop-down instead of a slide toward the beach, resulting from marine erosion.

The cliff face is exposed sufficiently to show a series of stratified sand gravel and clay overlying the vegetal deposit. About 200 yards southward is the lava-rock barrier of Cormorant Point, that forms the southern extremity of Cordova Bay. This barrier (to ice movement) once formed the southern margin of an Interglacial lake or swamp.

Judging from the general aspect of this vegetal deposit, with seams varying in thickness from 4 inches to 40 inches, the local vegetation received an additional amount of detritus, in the form of drift, from a locality immediately northward, through the agency of Vashon glaciation. Crushing and folding are in evidence throughout the whole mass of this superficial material, resulting from resistance at the barrier and pressure from the north.

Indurated silt-clay immediately overlying the vegetal deposit contains moderately scattered fragments of twigs, leaves and grasses; suggestive of lake-shore material washed in contemporaneously with the debris from the north, or soon after. No logs or stumps of trees have, as yet, been found in the matrix seams,

though a small piece of the branch of a cedar tree was picked out by the writer. The vegetal matter is a brown-black to black mass composed of swamp growth with fragments of small trees, shrubs, plants, sedges and grasses. When sun-dried the matrix assumes the near hardness of lignite. By immersion in water for a reasonable time the laminated peaty substance separates. Between the thin layers imprints of plants are discerned.

BEETLE ELYTRA: Several *elytra* of a metallic-green beetle were conspicuous among the peaty layers of the vegetal matrix when split apart. These, and other, insects are identical to the ones occurring in the Upper and Lower Lynn Series and the Scarborough Cliff Series of the Interglacial Period in Ontario, Eastern Canada.

GEOLOGICAL COMPARISONS: Although a distance of 70 miles, or so, separates the Vancouver Island deposits from those of the mainland there is but little difference in the stratigraphy and composition. Cordova Bay is similar to Point Grey shoreline exposures and both are situated at about the same land contour; they both face the Strait of Georgia. But whereas the Point Grey formation received its sediments from the Fraser Valley glacial route, in the main, Cordova Bay material was transported from the north, and contains considerable fragments of Coast Range rock.

The land being depressed during occupation by glaciers rose again on recession of the ice. At the time of Admiralty ice melt the areas specified in this report, as containing vegetal matter, were considerably below water level to permit silt deposits. Land uplift occurring soon after the retreat of the Vashon glacier elevated the Upper Lynn Series 825 feet above present sea level, while the Cordova Bay vegetal deposits record only a few feet. The mountain regions rose higher than the lowlands.

Under the black vegetal deposit at Cordova Bay there is a seam of indurated clay; it contains an occasional angular pebble of Coast Range origin and strata of fine sand, generally intercalated. The whole formation is underlain by stratified blue clay of Admiralty glaciation. Compared with the Upper Lynn Series these lower strata of the Cordova Bay formation are coeval. In their order of deposition the exposure at Cordova Bay show:

1. Surface soil and general level.

2. A steep slope with dense vegetation, trees, shrubs and plants, growing upon a strata of sand gravel and clays; having a vertical depth of approximately 180 feet.

3. 10 feet of indurated clay, interspersed with light vegetal remains. Folding is shown.

4. 40 inches of hard, compacted, black vegetal matter in shaly arrangement. This depth of 40 inches is the maximum thickness; the minimum being about 4 inches. The deposit displays folding and faulting and has a dip westward of about 25 degrees.

5. 4 feet of white clay-sand, very fine, with inclusions of calcareous concretions.

6. An undetermined depth of thinly stratified blue clay of Admiralty glaciation origin. Conforming with numbers 4 and 5, above, it dips westward at about the same angle.

3. A CHERMID WING FROM INTERGLACIAL LIGNITE

By W. DWIGHT PIERCE

While examining the interglacial lignite collected by Mr. Walter MacKay Draycot at Cordova Bay, Vancouver Island, British Columbia, the writer split a piece open and discovered a beautiful specimen of an almost perfectly preserved wing of a chermid. This specimen had one characteristic which set it off from most of the order, a cross vein between Radial sector and Media, forming a closed elongate, somewhat pentagonal discoidal cell.

In a search of the literature such a discoidal cell has been found only in 5 described genera, but in none of these was the cross vein in the same position. For this reason it is given a new generic name.

D. L. Crawford did not consider the wings alone sufficient for classifying the genera into groups, hence it is not definite to what subfamily the new genera should be assigned. However, since three genera with closed discoidal cells belong to the Cherminæ, it has been so assigned.

Only two fossil Psylloptera have been described from North America, *Necropsylla rigida* Scudder, based on 4 specimens, two of which are figured; and *Catopsylla prima* Scudder, both from Florissant, Colorado, shales (Scudder 1890. Tertiary Insects of North America).

If one can judge at all from the drawings, the two specimens of *Necropsylla rigida* do not belong to the same species, although they apparently have in common a cross vein between Media 3+4 and Cubitus 1. No. 310 also has a cross vein from Radial sector

to Media 1+2 beyond the forking of Media, and this is absent in No. 349. The Scudder types should be reëxamined, and if the drawings are correct one specimen should receive a new name.

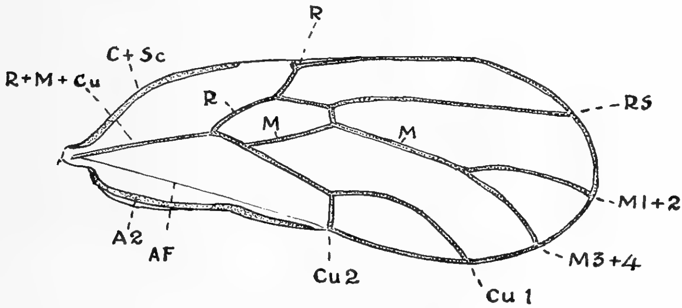


PLATE 9

Wing of *Draycotia cordovæ*. Pierce
Enlarged approximately X 30
Drawing by the author

A cross vein from Media to Cubitus is very rare although F. W. Pettey found it to occur as a variant in specimens of *Arytaina acaciæ-baileyanæ* (Froggatt).

Order PSYLLOPTERA Kraus & Wolff 1919.
Family CHERMIDÆ Kirkaldy 1904.
Subfamily CHERMINÆ VanDuzee 1916.
Genus DRAYCOTIA, new genus.
Type-*Draycotia cordovæ* new species (Plate 9).

The genus and species are described from a single wing (1945-269. CB-3), found on splitting a piece of interglacial lignite from Cordova Bay, Vancouver Island, British Columbia, collected by Walter MacKay Draycot, in whose honor the genus is named. The type is deposited in the Los Angeles County Museum.

Wing elongate, measuring 2.04 mm., narrower at apex of anal fold (0.07 mm.) than at apical fourth (0.84 mm.), apically rounded. The heavy Costa-Subcosta vein is marginal, not reaching the pterostigma. The Radio-media-cubital stem is more than one-fourth the length of the wing. It branches into Radial and Media-cubital stems. The Radial stem branches into Radius 1 and Radial sector, and is considerably longer than the Media-cubital stem. Radius 1 has a short spur to the margin, and with

it forms a narrow clear pterostigma, beyond which the Radius becomes marginal, extending around the periphery of the wing to the Anal fold. From Radial sector there is a cross vein to Media, which thus forms the one discoidal cell, irregularly elongate pentagonal in form. Media-cubital stem divides into Media and Cubitus, and each of these divides again, forming Media 1+2, Media 3+4, Cubitus 1, and Cubitus 2, the last almost vertical to the margin. The anal or vannal fold faintly extends from base of the wing to the end of Cubitus 2. One Anal vein (Anal 2) is present, but not marginal in all of its course; it reaches almost to the Anal fold.

The drawing is made from a photograph, and is correct in all proportions.

The genus can be separated from others having a discoidal cell by the following key:

Key to genera with closed discoidal cell formed by a cross-vein from radial sector to media, or by contact of these two veins.

1a. Media and Radial sector in contact at point of forking of media. Brazil) .... EPICARSA Crawford

b. Media and Radial sector united by a cross vein............ 2

2a. Cross vein reaching Media a considerable distance before its forking (British Columbia fossil)—DRAYCOTIA Pierce.

b. Cross vein reaching Media at or beyond the forking............ 3

3a. Cross vein reaching Media at its forking. (Tahiti)
.... MESOHOMOTOMA Kuwayama
.... TENAPHALARA Kuwayama

b. Cross vein reaching Media 1+2 beyond forking............ 4

4a. No cross vein between Media 3+4 and Cubitus 1. (Africa, South and Central America)............ CERIOCREMUM Enderlein
.... PHACOPTERON Buckton

b. Cross vein from Media 3+4 to Cubitus 1. (Colorado Florissant) .... NECROPSYLLA Scudder

BULLETIN of the SOUTHERN CALIFORNIA
ACADEMY of SCIENCES

Published by the Academy at Los Angeles, California
Subscription—$2.00 per year

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Began issue with Vol. 1, No. 1, January, 1902. Issued ten numbers in 1902; nine numbers in 1903, 1904, 1905; three numbers in 1906. Issued two numbers annually from 1907 to 1919, both inclusive (except 1908—one issue only). Issued four numbers (January, May, July and October) in 1920.

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BULLETIN OF THE
Southern California Academy of Sciences

LOS ANGELES, CALIFORNIA

Nostra tuebimur Ipsi

VOL. XLVII　　MAY-AUGUST, 1948　　PART 2

CONTENTS

Issued August 20, 1948

Southern California Academy of Sciences

Office of the Academy
Los Angeles County Museum, Exposition Park, Los Angeles 7, Calif.

Bulletin, Southern California Academy of Sciences

VOLUME 47 - - - - - - - PART 2, 1948

THE MATURE LARVA AND PUPA OF ARCTONOTUS TERLOOTII Hy. Edw.

By JOHN ADAMS COMSTOCK

One of the rarest and most colorful of the small sphinges of North America is *Arctonotus terlootii* Hy. Edw.

The species was first described by Henry Edwards in 1875[1] from "Two ♂ Coll. Dr. Behr, taken near Mazatlan, Mexico, by the late Baron Terloo, to whom, at Dr. Behr's request, I dedicate this interesting species."

Prior to this Dr. Behr had described a butterfly taken by "Baron Terloo in the pine forest region of the Sierra Madre . . . " naming it *Neophasia terlooii.*[2]

It will be noted that the original spelling of both these names was "terlooii," and not *terlootii.* The collector mentioned as "Baron Terloo" was actually Baron Terloot de Popelaire, and the later change of the name to *terlootii* was therefore correct procedure.

Arctonotus terlootii has been very infrequently mentioned in the literature, probably owing to its rarity. Herman Strecker treated it briefly in 1873[3] and gave an indifferent colored illustration.

Strecker correctly designated the collector as "the late Baron Terloot", but he retained the original spelling of terlooii, and placed it in the genus *Pterogon.*

Dr. Druce, in the Biologia, treats the species under the name *Proserpinus terlooi,* and states that the types were taken " . . . in the Sierra Madre, in the State of Sinaloa, by the late Baron Terloo."[4]

Dr. Dyar, in his list of 1902[5] placed the species in the genus *Lepisesia,* and retained the original spelling of the specific name. He gave locality as "Mex. Ga." It is doubtful if the moth occurs in Georgia.

Dr. Draudt in Seitz[6] follows the Biologia designation of *terlooi* and reports it as "hitherto only known from Mazatlan (Mexico)."

During August of 1946 the Los Angeles Museum had a group of its staff members in the field, collecting biological material in

[1]Proc. Cal. Acad. Sci. VI:90. 1875.
[2]Trans. Am. Ent. Soc. ii: 304. 1869.
[3]Lepid. Rhop. Het. 125. Pl. XIV, fig. 2. 1873.
[4]Biol. Cent. Am. Lep. Het. 1: 5. 1900.
[5]List of N. Am. Lepid. Bull. 52, U. S. Natl. Mus. 63. No. 662. 1902.
[6]Seitz. Macrolep. 6: 886. 1931.

the Santa Rita Mountains south of Tucson, Arizona. Among the lepidopterous larvæ obtained and successfully reared to maturity was a series found on *Boerhaavia coccinia* Mill., which proved to be *Arctonotus terlootii* Hy. Edw.

Four examples carried through to pupation, of which three emerged on the following dates: July 31, August 23 and August 26, 1947. The fourth specimen is still viable in July, 1948.

As no record of the early stages of this rare moth has been published to date it may be helpful to report such fragmentary notes as we have on its metamorphosis.

The foodplant grows closely appressed to the ground in areas of former clearings, and the larva being predominantly green is difficult to see.

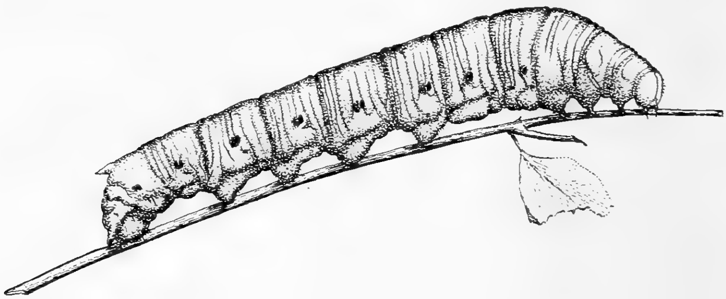

PLATE 10

Mature larva of *Arctonotus terlootii*, enlarged X approx. 1.2

Drawing by John A. Comstock

Mature Larva: Length, 65 mm. Color, predominantly light green, the abdominal surface slightly lighter than the dorsum.

Head slightly darker than the body. Ocelli, dark brown. Antennæ, bright green at the base, yellowish on terminal segments. Mouthparts, translucent, very light green, the mandibles edged with dark brown. Minute white hairs sparingly cover the head.

The dorsal area of the body is covered with minute round orange spots, each of which is marked in the center with a yellow dot bearing a short yellow hair. These orange spots are discernible with a hand lens. They are arranged in transverse rows, and tend to fade out in the area below the spiracles. These spots disappear in alcoholic specimens.

There is a slight suggestion of a longitudinal light band above the spiracles.

Caudal horn, short, and tinged with yellow.

Spiracles dark brown, margined with black, surmounted by a blue lunule and edged posteriorly with a dark brown shading.

Legs, translucent light green, the tip of terminal segment brown. Prolegs, light green, edged with a faint pink. Crochets black.

The mature larva is illustrated on Plate 10.

Pupation occurs under the ground.

PUPA. Length, 27 mm. Greatest width, 7 mm. Color, dark brown, the cephalic and caudal ends darker, and the metathorax black. The latter is heavily ridged.

Head rounded; eyes bearing a low papilliform protrusion.

The cremaster tapers to a point with a suggestion of fused double elements at the tip. It is flat laterally, and arrow shaped on dorsal aspect.

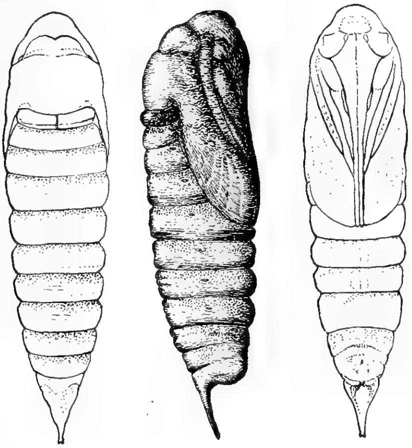

PLATE 11

Pupa of *Arctonotus terlootii*. Enlarged X 2.

Drawing by John A. Comstock

The maxillæ extend to the edges of the wings. Prothoracic leg prominent, and protruded as a rugose knob posterior to the eye. Antennæ extending 2/3 the distance toward the wing margins.

Texture of surface: Pro- and metathorax relatively smooth; anterior half of wing rugose; posterior half relatively smooth.

The anterior half of each abdominal segment is profusely pitted while the posterior half is smooth.

Spiracles inconspicuous, concolorous with body.

The pupa is illustrated on Plate 11.

FOSSIL ARTHROPODS FROM BRITISH COLUMBIA

4. AN ELAPHRUS FROM INTERGLACIAL LIGNITE

By W. DWIGHT PIERCE

As stated in Article 16 of the series "Fossil Arthropods of California," one fossil ground beetle of the genus *Elaphrus* was described from Interglacial clays of Scarboro, Ontario, and in that article another *Elaphrus* is reported from the California asphalt deposits at McKittrick and Los Angeles.

In the lignite material received from Mr. Walter MacKay Draycot, collected at Lynn Creek, British Columbia in interglacial deposits, was a rather badly crushed pair of elytra of an *Elaphrus* (LC 8) belonging to the group of almost impunctate elytra which includes *E. fuliginosus, E. lævigatus, E. clairvillei, E. olivaceus,* and *E. obliteratus.* Plate 12. represents an attempt at reconstruction of one of the elytra.

ELAPHRUS CLAIRVILLEI, LYNNI, new subspecies

These elytra measure separately 2.00 mm. in breadth and about 4.4 mm. in length, the tip being broken. This would in usual pro-

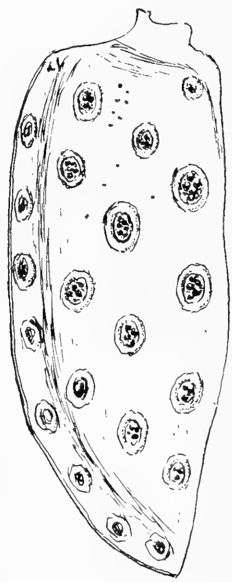

PLATE 12
Elytra of *Elaphrus clairvillei lynni*
Drawing by the author

portions make a total length for the insect of between 6 and 6.3 mm., which would make it smaller than most of the species in the group. It is only tentatively placed in *E. clairvillei.* The surface is smooth; the ocellate or crater-like foveæ are clearly defined by rounded rims surrounding a depression with several course punctures. The fourth or cubital series of foveæ are on a rim as in *E. ruscarius foveatus.* In this the new form differs from *E. clairvillei,* which has a convex outline throughout and almost no marginal concavity. The foveæ vary in size but average about 0.4 by 0.3 mm. in size.

FOSSIL ARTHROPODS OF CALIFORNIA

By W. DWIGHT PIERCE

16. THE CARABID GENUS ELAPHRUS IN THE ASPHALT DEPOSITS

Another evidence of the presence of water in the vicinity of the Los Angeles and McKittrick asphalt deposits is in the finding of the genus *Elaphrus* at both places.

This genus is Palæarctic, with 9 species in Europe and about 20 in North America, one, *E. riparius,* being on both continents. Only one fossil species has so far been described, *E. irregularis* Scudder, from the interglacial clay beds of Scarboro, Ontario. We are now able to add one species from California asphalt, and in the series Fossil Arthropods of British Columbia, article 4, a species from interglacial lignite.

The little beetles of this genus are found on sunny days running on sandbars and mud flats near streams and lakes; and in cloudy weather hiding under plants and rubbish. This occurrence checks with the Cicindelidæ, Haliplidæ, and Heteroceridæ which have been found, in indicating mud in the vicinity of the asphalt. They resemble tiger beetles in form, but their sculpture is distinctive, there being four series of large foveæ on the elytra, and no impressed striæ.

One perfect elytron was found in the McKittrick material collected by Leonard Bessom, of the Department of Earth Sciences of the Los Angeles County Museum, on August 10, 1947, at the 4 foot level at site 4; and a half elytron, somewhat crushed, but apparently the same species is at hand from Pit A, Rancho La

Brea, Los Angeles. It belongs to the *riparius, ruscarius* section of the genus.

ELAPHRUS RUSCARIUS FOVEATUS, new subspecies

This form is placed in *ruscarius* rather than in *riparius,* because the typical European *riparius* has very evident longitudinal ridges connecting the foveæ, whereas in *ruscarius* these are absent. If we had the whole insect it might very probably prove to be a distinct species.

Described from a perfect elytron, specimen McK 13a, from material collected August 10, 1947, by Leonard Bessom; washed from a clump of asphaltum taken at site 4, depth 4 ft., McKittrick asphalt field (see Article 14). It measures 1.76 to 1.92 mm. in width by 4.64 mm. in length.

The elytra of *Elaphrus* have not been carefully described. It will be recalled that in Article 2 of this series the writer showed that the beetle elytra are inverted, and that the scutellar margin is costal, and the humeral margin anal.

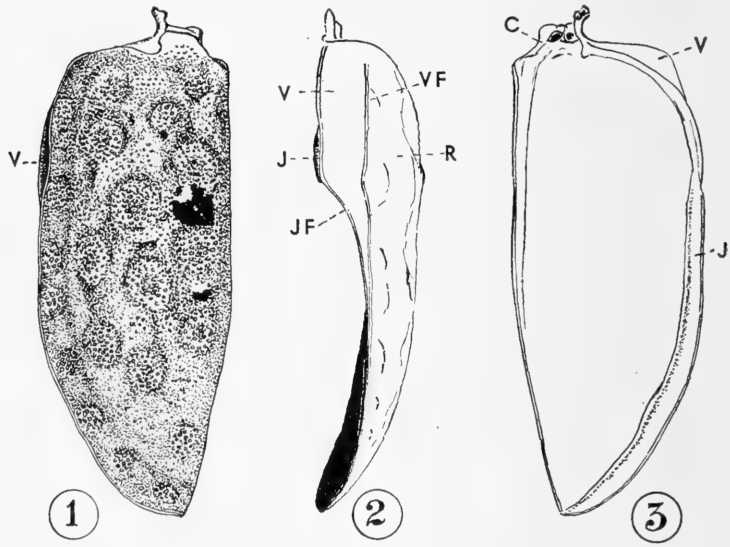

PLATE 13

Drawing by the author

FIGURE 1. Dorsal view of elytron of *Elaphrus ruscarius foveatus* Pierce. V—Vannus.

FIGURE 2. Humeral lateral view of same elytron. J—Jugum; JF—Jugal fold; R—Remigium; V—Vannus; VF—Vannal fold.

FIGURE 3. Outline of under view of same elytron. C—Costa; J—Jugum; V—Vannus.

This is again demonstrable in *Elaphrus,* and Figures 1, 2, 3 illustrate the four basic regions of a wing as defined by Snodgrass: (1) axillary, (2) remigial, (3) vannal, and (4) jugal. The three axillæ at the base of the elytron appear in Figure 3. The disc of the elytron is of course the remigium, and the Costa-Subcosta is evidenced by a tiny fold adjoining the scutellum in Figure 1, but in Figure 3, it can be seen that it forms the sutural rib. Interpretation of the remigial area is liable to error, but by comparison with *Carabus,* it has been decided that the foveæ are interstitial, not strial.

With this interpretation, the first row of 6 foveæ are radial, i.e. between Radius and Radial sector; the second row of 5 foveæ lies between Radial sector and Media 1; the third row of 5 foveæ as between Media 1 and Media 2, or Paracubitus; the fourth row of 5 foveæ between Media 2, or Paracubitus, and Cubitus. They all lie in the remigium, which is greatly wrinkled, due to the uneven distribution of the shallow foveæ. Each of the foveæ is a depression with a number of coarse punctures, and in life the depressions were probably of a different color from that of the surrounding area.

The entire surface is densely punctate, except for a large smooth raised spot between second and third radial foveæ, and a smaller smooth spot between third and fourth radial foveæ. The area covered by the first three rows is generally convex; and the fourth row lies on a lateral shelf with raised edge. This edge is the Vannal fold, which defines the lateral humeral vertical area, shown in Figure 2, the Vannus. This is densely punctate, with sides almost parallel to beyond the basal fourth, then strongly narrowed until beyond the middle it becomes a linear strip between two ridges. The outer ridge or edge is the jugal fold, and in Figure 3 it can be seen that the jugum is an infolded area on the inside of the elytron, extending to the apex, and marked inwardly by a sharp uplifted edge. The Vannus has been called Epipeura in Coleopterous literature. The internal Plica of early descriptions is the Jugum.

The specimen from Pit A, Rancho La Brea, has the same measurement and sculpture, but is only the anterior end of an elytron, and is not considered as a type specimen. This is specimen C 127a.

ANNOTATED BIBLIOGRAPHY OF THE LINGUATULIDA

By HOWARD R. HILL

The Order *Linguatulida* comprises a group of worm-like parasites closely related to arachnids. In the literature, linguatulids are frequently referred to the Order *Pentastomida*. The former name, however, seems more appropriate as *Linguatula* was the first genus described.

Because of their medical importance, structural peculiarities and complicated life history, the *Linguatulida* have long been of interest to physicians, veterinarians and zöologists. Publications concerning them are difficult to obtain. It is hoped that this Bibliography will be helpful as a guide to the literature on the group. After many titles, a short digest is appended in parenthesis to indicate the subject matter or designate the correct specific name of the species under discussion.

At the conclusion of the Bibliography, a Summary of Important Articles, designates by number the publications deemed most useful by the present writer. The Summary is divided into the following Sections: I. General-Account of the *Linguatulida*. II. Phylogeny. III. Life History. IV. Distribution. V. Morphology. VI. Classification. VII. Pathology.

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SUMMARY OF IMPORTANT PUBLICATIONS

(The numbers refer to the corresponding numbers in the Bibliography)

I. General Account of the Group: 4, 36, 57, 60, 87, 152, 163, 168, 223, 257, 307, 309, 316.

II. Phylogeny: 136, 139, 179.

III. Life History: 41, 71, 173, 223, 261, 335.

IV. Distribution: 119, 170, 309, 338-343.

V. Morphology: 21, 116, 118, 130-135, 138, 139, 152, 155-157, 202, 223, 228, 245, 262, 309, 329, 334.

VI. Classification: 87, 152, 155, 156, 168, 179, 223, 309, 316.

VII. Pathology: 3, 36, 40, 41, 53, 71, 218, 221, 225, 303, 307, 314, 325.

BULLETIN of the SOUTHERN CALIFORNIA
ACADEMY of SCIENCES

Published by the Academy at Los Angeles, California
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LOS ANGELES, CALIFORNIA

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VOL. XLVII SEPTEMBER-DECEMBER, 1948 PART 3

CONTENTS

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Bulletin, Southern California Academy of Sciences

VOLUME 47 - - - - - - PART 3, 1948

THE RELATIVE LENGTHS OF LIMB ELEMENTS IN CANIS DIRUS

By CHESTER STOCK AND JOHN F. LANCE

Introductory remarks.—The lengths of four limb elements (humerus, radius, femur and tibia) belonging to the dire wolf, *Canis (Aenocyon) dirus,* were measured for a large number of fossil specimens available from the Pleistocene asphalt of Rancho La Brea. The study was undertaken primarily to determine the correct proportions of the limbs, and thus assist in current attempts to restore this characteristic wolf of the Ice Age. In addition, the results of the measurements were utilized to calculate the arithmetic mean, standard deviation and coefficient of variation, and thereby add to the information obtained from a study of the metapodials.[1] The measurements furnish precise data that are useful in comparing the lengths of the limb elements of the extinct dire wolf with those of the living gray or timber wolf and supplement the observations of Merriam.[2] In the subspecific identification of the skeletal material of modern timber wolves referred to in this paper the authors follow the terminology of Young and Goldman.[3]

Materials available.—The total number of specimens for each of the limb elements of one side measured in *Canis dirus* was as follows:

Humerus	496	Femur	313
Radius	740	Tibia	687

The disparity in numbers for individual elements was in large measure due to the selection only of complete specimens. The radii were particularly numerous, the abundance of this element coming nearest to that of the metapodials.

In contrast, the sample of limb elements of the living wolf is

[1]Nigra, John O. and John F. Lance, Bull. So. Calif. Acad. Sci., vol. 40, pt. 1, Jan.-Apr., pp. 26-34, pls. 6-8, 1947.

[2]Merriam, John C., Mem. Univ. Calif., vol. 1, no. 2, pp. 236-240, 1912.

[3]Young, Stanley P. and Edward A. Goldman, The Wolves of North America, xx + 636 pp., illust., The American Wildlife Institute, Wash., D. C., 1944.

very small. Only eight individuals of the living species were available, as follows:

Canis lupus occidentalis ♂ No. 98231 A.M.N.H., Alberta, Canada
Canis lupus occidentalis ♂ No. 98226 A.M.N.H., Alberta, Canada
Canis lupus occidentalis ♀ No. 98231 A.M.N.H., Alberta, Canada
Canis lupus occidentalis ♀ No. 98227 A.M.N.H., Alberta, Canada
Canis lupus occidentalis ♀ No. 98225 A.M.N.H., Alberta, Canada
Canis lupus lycaon ♀ No. 51773 C.M.N.H., Wisconsin
Canis lupus lycaon ♂ No. 51772 C.M.N.H., Wisconsin
Canis lupus irremotus ♂ No. 271651 U.S.N.M., Montana

Computations and comparisons.—In Plate 14 are shown the frequency distribution curves of the lengths of the humerus, radius, femur and tibia of the extinct dire wolf. The following statistical data are computed from these lengths:

Limb Element (Right)	O. R.[1] in mm.	S.R. (S.D.)[2] in mm.	Mean in mm.	Standard Deviation in mm.	Coefficient[3] of Variation
Humerus........	47	58	217.9 ± .4	9.0 ± .3	4.1 ± .1
Radius..........	50	52	209.4 .3	8.0 .2	3.8 .1
Femur...........	43	55	241.8 .5	8.5 .3	3.5 .1
Tibia............	49	57	231.6 .3	8.8 .2	3.8 .1

[1]O.R. = Observed Range.

[2]S.R. (S.D.) = Standard Range from Standard Deviation. Estimate of mean population range for population abundance of 1000 (Simpson, G. G., 1941, Am. Journ. Sci., vol. 230, pp. 785-804).

[3]100 times Standard Deviation divided by mean (Simpson, G. G., and A. Roe, 1939, Quantitative Zoology, McGraw Hill Book Co., New York).

In Plate 15 are given the measurements of the average lengths of the limb elements of *Canis dirus.* With these are included the average lengths of metacarpal III and metatarsal III of the extinct Pleistocene species as determined by Nigra and Lance.[4] In the same diagram are also recorded the lengths of the comparable elements of the timber or gray wolf, based on the eight individuals listed above and representing three subspecies of *Canis lupus.*

Plate 16 shows diagrammatically the relative lengths of the bones in the fore and hind limbs taking the length of the humerus

[4]Nigra, John O. and John F. Lance, ibid., 1947.

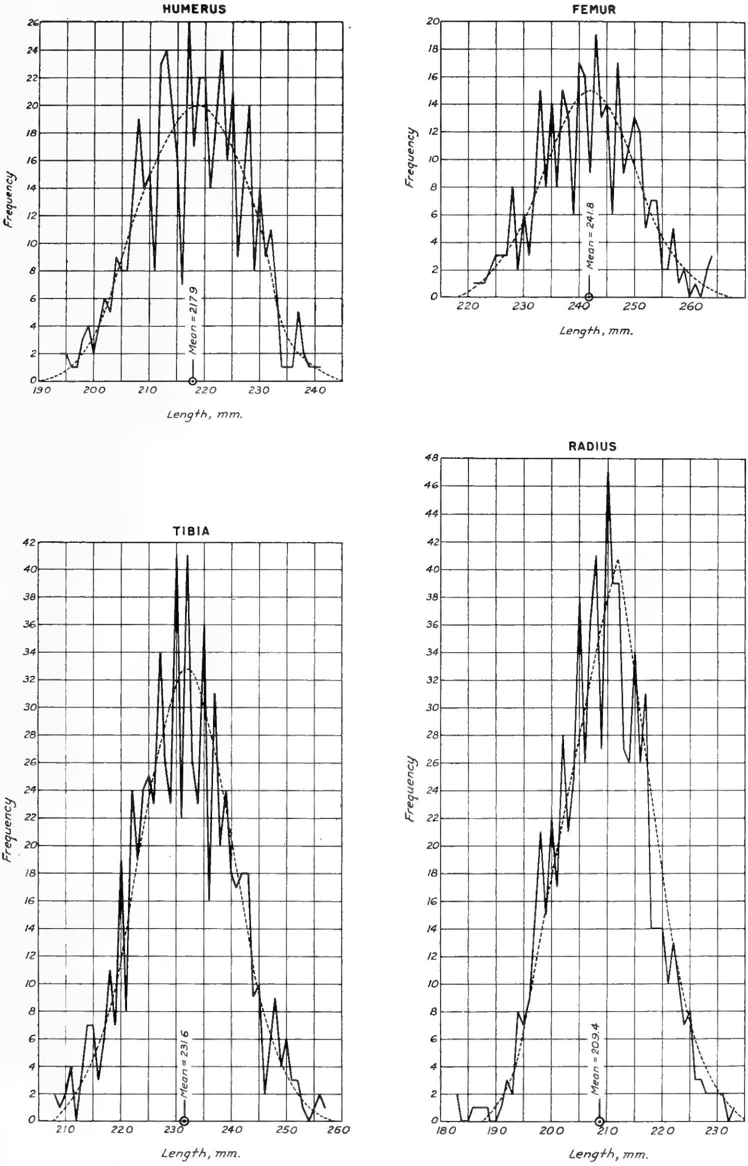

PLATE 14

Frequency distribution curves of the lengths of the humerus, radius, femur and tibia of the extinct dire wolf (*Canis* (*Aenocyon*) *dirus* Leidy) from the Pleistocene of Rancho La Brea.

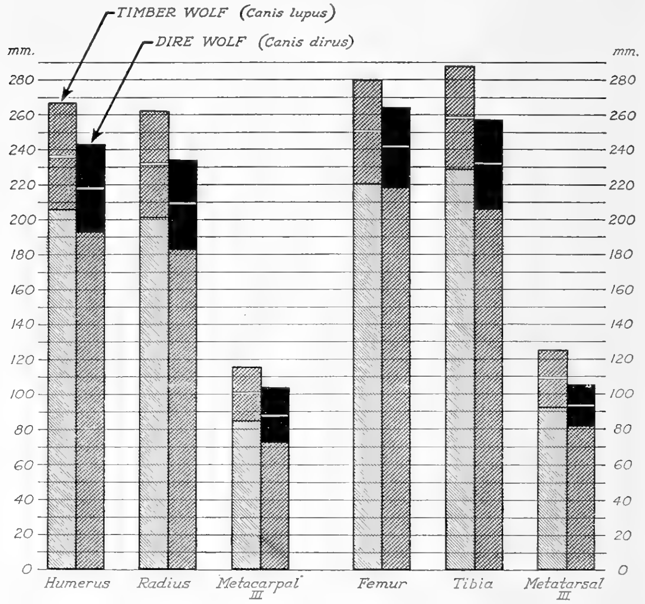

PLATE 15

Bar diagram showing by comparison the maximum, minimum and mean lengths of the limb bones of the dire wolf and the timber wolf.

and femur as 100. The following indices are derived from the measurement data:

Intermembral Index $\frac{\text{Humerus} + \text{Radius}}{\text{Femur} + \text{Tibia}} \times 100$:

Canis dirus	90.0
Canis lupus	92.3

Radiotibial Index $\frac{\text{Radius}}{\text{Tibia}} \times 100$:

Canis dirus	90.4
Canis lupus	90.6

Humerofemoral Index $\frac{\text{Humerus}}{\text{Femur}} \times 100$:

Canis dirus	90.1
Canis lupus	95.1

A consideration of the ratios derived from the measurements of the limb bones in *Canis dirus* and in the northern timber wolves leads to the following conclusions:

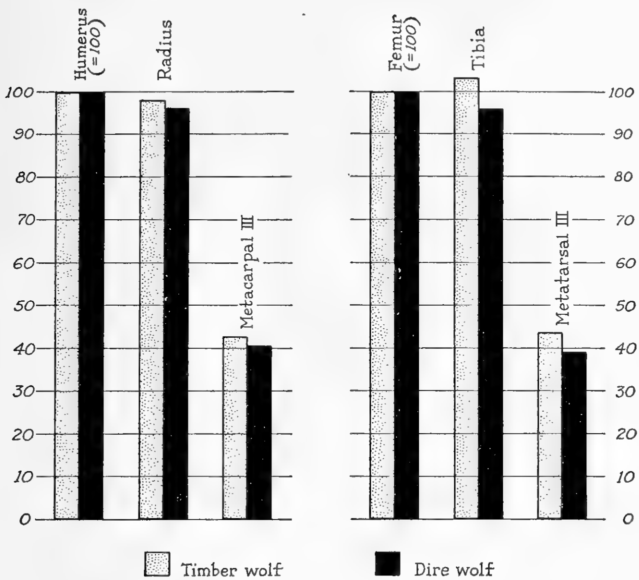

PLATE 16

Bar diagram showing relative lengths of radius and metacarpal 3 compared with humerus, and of tibia and metatarsal 3 compared with femur in dire wolf and timber wolf.

(1) In size (exclusive of that of skull, scapula and pelvis) *Canis dirus* was, on the average, approximately 8 per cent *smaller* than that of the northern subspecies of timber wolf (*C. lupus occidentalis*).

In this connection it must be indicated that the subspecies of gray wolf (*Canis lupus irremotus*) of more southerly range in North America is a smaller animal than the northern wolf (*Canis lupus occidentalis,* No. 98227 Amer. Mus. Nat. Hist.) from Alberta, Canada, on which the above statement is based. In a previous paper the dire wolf was illustrated as possessing an overall size larger than that of *Canis lupus irremotus.*[5]

(2) In comparison to the great northern timber wolf (*Canis lupus occidentalis*), the extinct dire wolf from Rancho La Brea had a relatively shorter fore limb (humerus + radius + metacarpus) and, conversely, a relatively longer hind limb (femur + tibia + metatarsus). This difference, however, is slight. The

[5]Stock, Chester, John F. Lance and John O. Nigra, Bull. So. Calif. Acad. Sci., vol. 45, pt. 2, pp. 108-110, pl. 9, 1946.

most outstanding difference between these two wolves exists in the tibio-femoral and metatarso-femoral indices. *Canis dirus* had a significantly shorter tibia and metatarsus than *Canis lupus occidentalis*. The shortness of the lower segments in the hind limb, seen also in the fore limb but to less degree, may be construed to mean that the Pleistocene dire wolf was not so fleet of foot as the Recent timber wolf.

California Institute of Technology,
Division of the Geological Sciences,
Contribution No. 460.

A STATISTICAL STUDY OF THE METAPODIALS OF EQUUS OCCIDENTALIS LEIDY

By DAVID P. WILLOUGHBY

INTRODUCTION

A survey and statistical analysis of most of the skeletal elements of the Rancho La Brea horse (*E. occidentalis* Leidy) and of other equine species living and extinct, is being made by the author. In the present paper the only bones of *E. occidentalis* to be dealt with are the fore and hind metapodials. Although skeletal remains of this species of horse occur likewise in the Pleistocene asphalt of McKittrick, California, only the metapodials of the Rancho La Brea horse are here treated statistically. The skeletal elements of *Equus occidentalis* in the Rancho La Brea collection of the Los Angeles Museum were generously made available for measurement and study. It is a pleasure to acknowledge the opportunity to analyze these specimens.

REMARKS CONCERNING EQUUS OCCIDENTALIS

The name *Equus occidentalis* (Leidy, 1865) is used in reference particularly to the equine skeletal remains recovered from the Pleistocene tar deposits of Rancho La Brea and McKittrick, in California. The possibility that the name should be replaced by the prior designation *Equus excelsus* (Leidy, 1858) depends upon whether *E. occidentalis* is to be considered a synonym of *E. excelsus* or a distinct species. Since, however, identification of *E. excelsus* is uncertain because of insufficient material; and in view of its wide geographical separation (Nebraska) from the Pacific coast Pleistocene horses, it is probably best to regard *E. occidentalis* as a species distinct from *E. excelsus*. The Californian species, *E. pacificus*, has also been confused with *E. occidentalis*. A detailed study of the teeth, metapodials, and phalanges of the latter

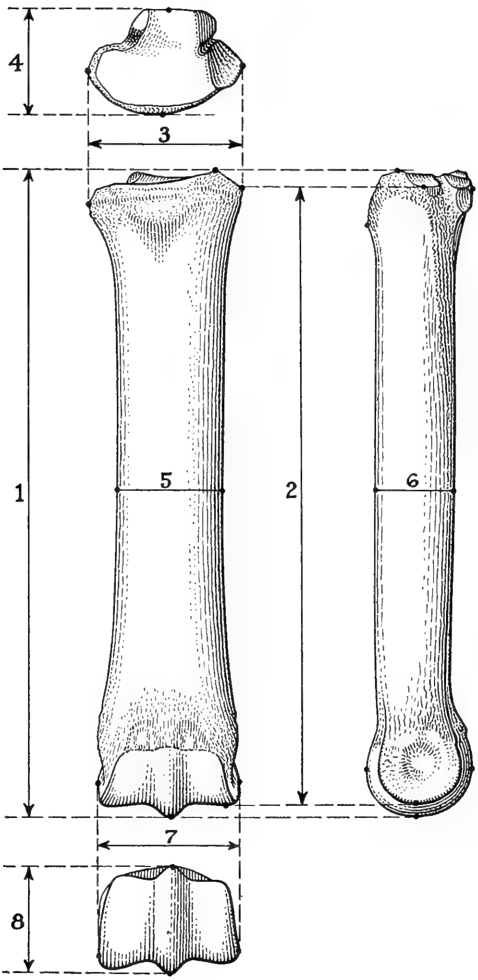

PLATE 17

Scale drawing, 1/3 natural size, of left metacarpal III of *Equus occidentalis* (average-sized specimen). The measurements indicated, and the technique of taking them, are explained in the text.

shows, however, that *E. pacificus* stood in life no less than 64 inches at the shoulder and was proportionately larger than *E. occidentalis* in almost every respect; the enamel pattern of its teeth was distinctly more complicated; and its horse-like hoofs, unusual among wild Equidæ, were much broader and less asinine than those of *E. occidentalis.* Thus there can be no doubt as to the specific differentation of these two Pleistocene equine types.

Such a large amount of skeletal material, particularly of the limb bones, of *E. occidentalis* has been recovered, perfectly preserved, from the asphalt localities of Rancho La Brea and McKittrick that the characteristics of this species in every detail are now either known or are determinable. No other species of fossil horses have been found either at Rancho La Brea or McKittrick. Therefore, unless a future revision of the entire list of Pleistocene horses renders the name *Equus occidentalis* untenable, the author shall continue to apply it to the equine material found, in particular, at Rancho La Brea and at McKittrick.

Equus occidentalis, or the fossil "western horse," was from a morphological point of view a disharmonic and distinctive equine type. If it should be discovered that other Pleistocene horses tended to the same conformation, it can be said that all such "horses" differed decidedly in their head, body and limb proportions from any single breed of domesticated horse of the present time. In shoulder height an average-sized *E. occidentalis* stood about the same as an average-sized Arab horse, namely 58 inches or 14½ hands. Its limb-bone lengths and proportions, and its small hoofs, were characteristic of those of a present-day Burchell's zebra. Yet oddly enough it combined with these cursorial features a robustness of build comparable to that of a draft horse. Its large skull was suggestive of the head-to-body proportions of a zebra. Its strongly-formed pelvis, while quite variable individually, tended more toward the high and narrow asinine type than the broad and low equine type. Thus, to repeat, *E. occidentalis,* was physically a "horse" of very heterogeneous characters.

PROCEDURE

Eight separate measurements were recorded of 74 metacarpals and of 112 metatarsals belonging to *E. occidentalis* of Rancho La Brea and including specimens of both right and left feet. From these eight dimensions seven indices were computed. A statistical presentation of these dimensions and indices is given in Tables 1 and 2. The measurements used, and the measuring technique employed, were as follows (see Plates 17 and 18).

Measurement 1. Maximum length. This is the greatest length of the bone, parallel to its long axis, inclusive of the proximal lateral spine and the distal sagittal ridge.

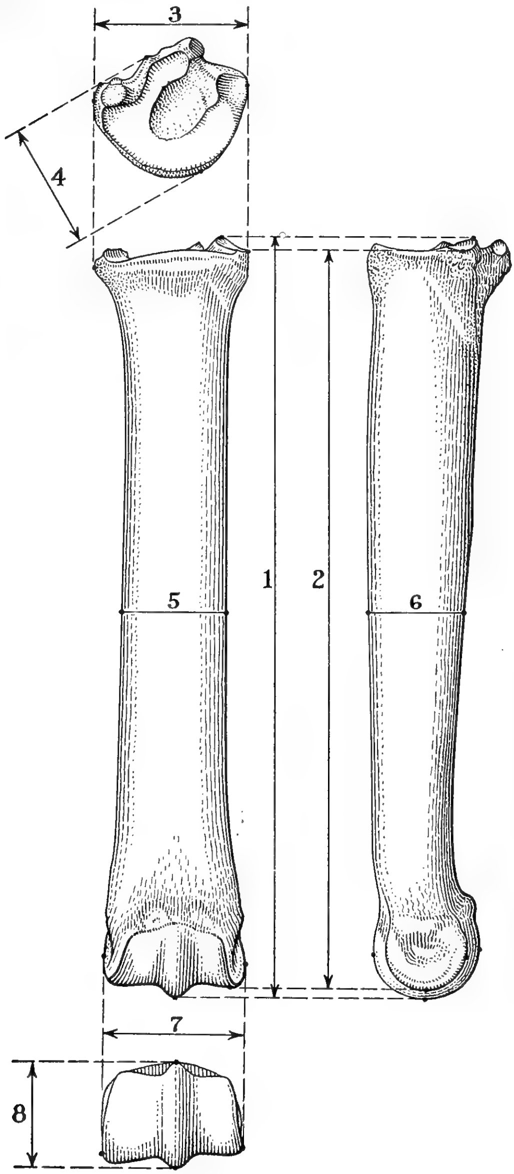

PLATE 18

Scale drawing, 1/3 natural size, of left metatarsal III of *Equus occidentalis* (average-sized specimen). The measurements indicated, and the technique of taking them, are explained in the text.

Measurement 2. Articular length. From the lateral edge of the facet adjoining the fourth carpal bone to the lateral distal edge of the trochlea, in line with the long axis of the shaft.

Measurement 3. Maximum proximal width. The greatest lateral width of the top of the bone, roughly parallel to the lateral axis of the shaft.

Measurement 4. Maximum proximal antero-posterior depth. The greatest sagittal diameter at the upper end, including the anterior tubercle. In the metacarpal this diameter is approximately parallel with the sagittal axis of the shaft. In the metatarsal, however, the measurement is taken with the bone rotated about thirty degrees from the sagittal plane, as shown in the top view in Plate 18.

Measurement 5. Minimum width of shaft. The least lateral diameter of the shaft, approximately at the middle of the length of the bone.

Measurement 6. Minimum antero-posterior depth of shaft. Taken approximately at the middle of the length of the bone and including any volar ridges.

Measurement 7. Maximum distal articular width. The greatest lateral diameter across the volar surface of the trochlea. (The width across the apophyses is, on the average, about the same as the articular width.)

Measurement 8. Maximum distal antero-posterior depth. The greatest diameter antero-posteriorly of the distal sagittal ridge.

Plate 19 shows the frequency distribution of the maximum lengths of 74 metacarpals. Also plotted on the graph in a dotted line is a normal frequency curve. Although the frequencies in the observed distribution fluctuate widely, they appear to conform reasonably well with the theoretical curve. It is apparent that the distribution is unimodal. The mean length (maximum) of the third metacarpal is 252.5 mm., ranging in 74 specimens from 237 mm. to 269 mm. As a matter of interest, the length was computed separately for the right and left sides, but no significant difference was found. The average of the right metacarpal series is 251.5 mm.; that of the left metacarpal series is 253.5 mm. There is probably a sex-differentiation of about 3 mm., the male metacarpals averaging 254 mm. in length and the female metacarpals 251 mm.

Plate 20 similarly is a plotting of 112 metatarsals. Again the dotted line indicates the normal frequency curve, and to it the observed data conform. The mean length (maximum) of the third metatarsal is 292.4 mm., ranging in 112 specimens from 279 to 311 mm. It thus exceeds the length of the metacarpus by 15.8 per cent, or roughly 40 mm. This ratio between the length of the

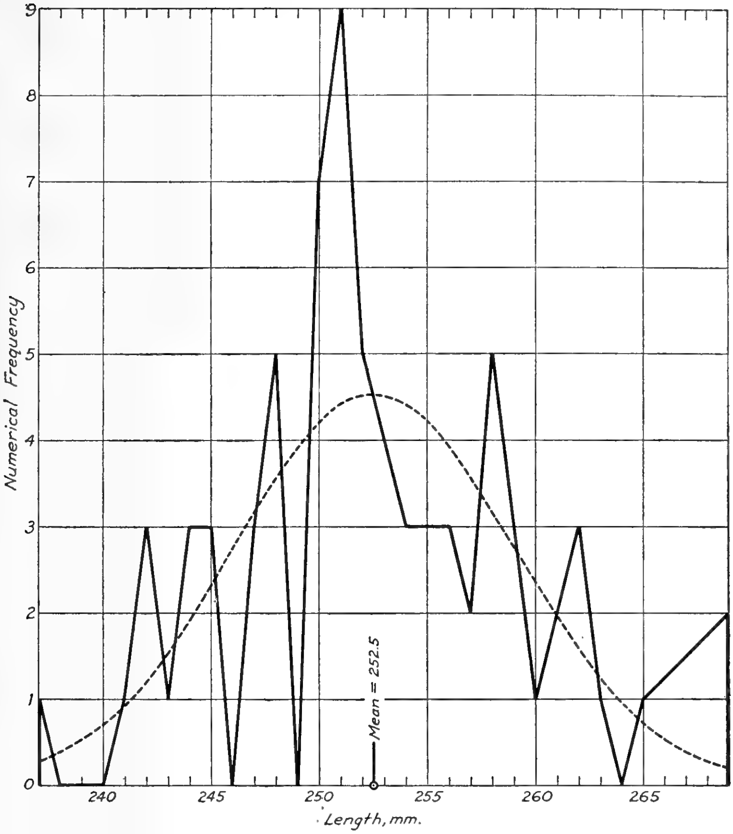

PLATE 19

Frequency distribution of the lengths (maximum) of 74 metacarpals of *Equus occidentalis*, ranging in length from 237 mm. to 269 mm.

metatarsus and the metacarpus approximates closely that which exists in the modern domesticated horse.

In comparison with the metapodials of modern horses, those of *E. occidentalis* are noteworthy in their general appearance mainly for their massiveness and robustness. Certain details of the bones, in their size and proportions, differ appreciably in the typical *E. occidentalis* from those most typical of living horses. Yet certain individual specimens of *E. caballus*, particularly those of semi-draft build, may have metapodials which are practically indistinguishable from those of certain individual Rancho La Brea horses. As a single instance of this variation, it may be

noted that on the proximal surface of the third metatarsal bone the posterior facet for the third tarsal (ectocuneiform) is, in present-day domestic horses, commonly separated from the large anterior U-shaped facet by a distinct depression or trough. In most specimens of *E. occidentalis* this separating trough is absent, as is shown in the top view of the third metatarsal in Plate 18.

In *E. occidentalis* the minimum caliber index (no. 4 in Table 1, under Indices) for the metacarpus is 16.9 in the male. The average value of this index in Thoroughbred stallions is 13.85, and in Percheron (draft) stallions, 18.5. Thus, in this particular index, *E. occidentalis* stood much closer to a draft horse than to a racehorse. If the width of the proximal end of the third metacarpal be taken in comparison with the length of the bone, *E. occidentalis* stood exactly half-way between the draft and the speed types of modern horses. By any standard the metapodials are relatively *thick,* and indicate, together with other bones of the limbs, an equine type of comparatively heavy build.

A graphic plotting of the metacarpal caliber index of *E. occidentalis* shows clearly a bimodal distribution and suggests sexual differentiation. This is indicated also by the relatively high value (6.08) of the coefficient of variation for measurement number 5 in Table 1. If a C.V. of 3.80 (a good average value for other width and depth measurements) be applied to the minimum width of shaft, the range of this dimension in 74 specimens would be from 36.2 mm. to 43.4 mm., whereas actually it ranged from 33.7 mm. to 44.6 mm., a range over 50 per cent greater. The same sex difference is shown in the minimum width of the metatarsus. Since all immature bones were excluded from consideration, the difference is mainly or wholly sexual rather than due to age, although it is possible that the metapodial caliber index does increase slightly with age. That there probably existed in the metapodial caliber index a sex difference of the degree we have assumed is interestingly suggested by measurements of the girth of the fore and hind cannons in living horses. If an index be made by relating shoulder height to girth of the fore cannon, in Percheron horses the average value of this index is 16.05 for stallions and 15.05 for mares. In the Argentine Criollo horse, the index is 13.60 for stallions and 12.96 for mares. Thus, the relative girth of the cannon (and presumably of the underlying metacarpal bone) is in the Percheron horse 6.6 per cent greater, and in the Criollo horse about 5 per cent greater, in stallions than in mares.

The corresponding difference deduced from the metacarpal caliber index in *E. occidentalis* is a male superiority of 6.5 per cent. Curiously, this sex differentiation, while of marked degree in the caliber of the middle of the metapodials, is only slight in the proximal and distal ends. This is true both of the bones of *E. occidentalis* and of modern horses. Finally, the superiority ex-

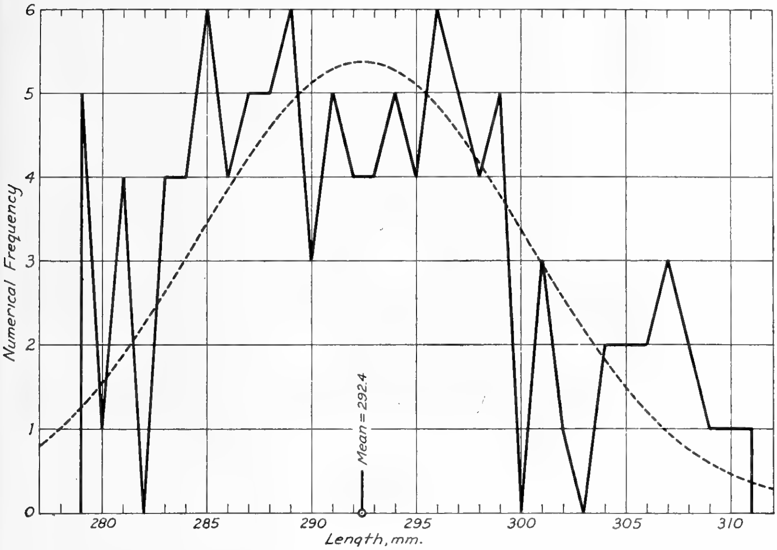

PLATE 20

Frequency distribution of the lengths (maximum) of 112 metatarsals of *Equus occidentalis*, ranging in length from 279 mm. to 311 mm.

isting in the caliber of the metapodials in the male horse is not generally evident in the other long bones of the limbs, with the possible exception of the phalanges. In the draft horse, at least, the hoof bones are distinctly broader in stallions than in mares. No attempt has been made to determine the sex of the bones of the third or ungual phalanx in *E. occidentalis*, since the coefficients of variation for measurements of this element show only moderately high values.

An index useful in showing further the sexual differentiation of the metapodials in *E. occidentalis* is the ratio of measurement number 3 to measurement number 5. If the maximum proximal width of the metacarpus be assumed as 100.0, the minimum width of the shaft in males is, on the average, 68.7, ranging in 37 specimens from 64.8 to 73.2. In female the average index is only 65.6, ranging in 37 specimens from 59.5 to 72.6. The same male superiority in the thickness of the shaft relative to the ends of the bone is presented in metapodials of modern domestic horses. This thickness of the mid-shaft relative to the widths of the ends is, however, noticeably greater in *E. occidentalis* than in most specimens of living horses. Thus the metapodials of the Rancho La Brea horse may be described as of more uniform caliber, with less

flaring of the ends, than those characteristic of modern horses. Particularly is the distal width of the metapodials in *E. occidentalis* relatively narrow, and this conformation possibly is correlated with the small, zebra-like hoofs typical of this species.

No specimens of the second and fourth metapodials, or "splint" bones, were studied. The extent of the two longitudinal roughened areas on the volar surface of the third metapodials, and the width across the articulating facets, indicate, however, that the splint bones were of about the same proportionate length and caliber as those existing in modern horses.

The range in length of the metapodials and of other long bones signifies that the largest individual animals in an entire equine population are about 10 per cent larger in linear dimensions than the average-sized specimen. Thus the largest individuals of *E. occidentalis* would stand at the shoulder about 64 inches.

SUMMARY

Eight measurements and seven indices of the middle metapodials of *E. occidentalis* are recorded and the data compared with similar information on living domestic horses of various breeds. These measurements and indices, taken together with those of other long bones of the skeleton, permit an osteometric restoration of *E. occidentalis*. Tentatively, this fossil horse of Rancho La Brea may be described as of moderately-large size (58 inches in shoulder height) and fairly heavy build, with long head, sturdy limbs, and small, zebra-like hoofs.

The mid-width caliber indices of the metapodials of *E. occidentalis* indicate a sexual differentiation. The metapodial bones of males, for a given length, average 6.5 per cent thicker in the middle than those of females. The sex difference in the relative caliber of the ends of the bones, although suggested, is slight. These differences in relative caliber appear to be substantiated by similar metapodial indices recorded of modern domestic horses, as well as by girth measurements of the cannons of living horses made on both sexes of given breeds.

California Institute of Technology,
Division of the Geological Sciences,
Contribution No. 464

TABLE 1

Dimensions and proportions of metapodials of Equus occidentalis from Rancho La Brea

74 Specimens of Metacarpal III

Measurements	Mean	S.D.	C.V.	Range	
				Observed	Standard (1000)
1. Maximum length	252.5±0.8	6.52	2.58	237—269	231—274
2. Articular length	242.4±0.8	6.69	2.76	228—259	221—264
3. Maximum proximal width ♂ Maximum proximal width ♀	59.7±0.3 59.1±0.3	2.28	3.84	54.5—65	52 — 67
4. Maximum proximal A-P depth	41.6±0.2	1.58	3.80	38 —45	37 — 47
5. Minimum width shaft ♂ Minimum width shaft ♀	41.1±0.3 38.6±0.3	2.42	6.08	35 —44.6	33 —47.6
6. Minimum antero-posterior depth	31.5±0.1	1.10	3.49	29 —34	28 —35
7. Maximum distal articular width ♂ Maximum distal articular width ♀	54.9±0.2 54.5±0.2	2.08	3.81	49 —59	48 —61
8. Maximum distal A-P depth	41.5±0.2	1.50	3.62	38 —45	37 —46

INDICES

1. Maximum length / articular length x 100	104.2
2. Maximum proximal width / articular length x 100 ♂ Maximum proximal width / articular length x 100 ♀	24.6 24.4
3. Maximum proximal A-P depth / articular length x 100	17.2
4. Minimum width shaft / articular length x 100 ♂ Minimum width shaft / articular length x 100 ♀	16.9 (16.0 — 18.0) 15.9 (13.8 — 17.4)
5. Minimum A-P depth, shaft / articular length x 100	13.0
6. Maximum distal articular width / articular length x 100 ♂ Maximum distal articular width / articular length x 100 ♀	22.7 22.5
7. Maximum distal A-P depth / articular length x 100	17.1

TABLE 2

Dimensions and proportions of metapodials of Equus occidentalis from Rancho La Brea

112 Specimens of Metatarsal III

Measurements	Mean	S.D.	C.V.	Range	
				Observed	Standard (1000)
1. Maximum length	292.4±0.8	7.81	2.67	279—311	267—317
2. Articular length	285.4±0.8	7.81	2.74	272—303	260—310
3. Maximum proximal width ♂	59.1±0.2	2.25	3.83	53.7—65.0	51.5—66.1
Maximum proximal width ♀	58.5±0.2				
4. Maximum proximal A-P depth	48.5±0.2	1.83	3.78	44 —53.4	42.6—54.5
5. Minimum width shaft ♂	40.2±0.3	2.76	7.09	33 —47	32.3—46.6
Minimum width shaft ♀	37.7±0.3				
6. Minimum antero-posterior depth	37.1±0.2	1.51	4.08	33.4—41	32.2—42
7. Maximum distal articular width ♂	54.4±0.2	2.06	3.80	51.9—59.8	47.5—60.9
Maximum distal articular width ♀	54.0±0.2				
8. Maximum distal A-P depth	40.6±0.1	1.46	3.60	36.8—45	35.8—45.3

INDICES

1. Maximum length / articular length x 100	102.5
2. Maximum proximal width / articular length x 100 ♂	20.7
Maximum proximal width / articular length x 100 ♀	20.5
3. Maximum proximal A-P depth / articular length x 100	17.0
4. Minimum width shaft / articular length x 100 ♂	14.1 (13.2 — 16.5)
Minimum width shaft / articular length x 100 ♀	13.2 (11.6 — 14.7)
5. Minimum A-P depth, shaft / articular length x 100	13.0
6. Maximum distal articular width / articular length x 100 ♂	19.1
Maximum distal articular width / articular length x 100 ♀	18.9
7. Maximum distal A-P depth / articular length x 100	14.2

DESCRIPTION OF A NEW SPECIES OF BARNACLE FROM PANAMA

By FRANK LEE ROGERS
California Academy of Sciences

In 1941, Mr. W. D. Clark, Canal Zone, Panama, presented five specimens of a barnacle to the California Academy of Sciences. These specimens, taken at Chamé Point, Canal Zone, Panama, represent a species possessing unusual and distinctive characters which, so far as is known, has not hitherto been described.

BALANUS PANAMENSIS F. L. Rogers, new species
(Plates 21 and 22)

GENERAL DESCRIPTION. Barnacle of medium size, varying in shape from a fairly steep to a spreading conic form; orifice toothed when not eroded, somewhat heart-shaped; color of young specimens vinaceous but on old forms the color is faded and obscured by various growths on the shell.

SIZE. Dimensions of the holotype: carinorostral diameter, 45 mm.; lateral diameter, 40 mm.; height of carina, 39 mm.; height of rostrum, 32 mm.; length of orifice, 15 mm.

SCUTUM. Valve somewhat concave, apex acute but not beaked, basal border nearly as long as the tergal border; sculpture consists of about 25 prominent, transverse ridges which are cut deeply by longitudinal furrows, forming rows of short cylinders; in young specimens each cylinder has a central pit, from which a hair grew, judging from one specimen which showed rudiments of such growth, in older specimens the lower part of the cylinder is eroded away, leaving a small arch; articular ridge short, rather high, ending in an obtuse point in adult specimens; adductor ridge in young specimens separated from the articular ridge by a space but in older specimens the two ridges nearly touch due to considerable thickening of the valve, this thickening causes a remarkable difference in appearance between young and old valves. There is a possibility that there is a varietal difference between the valves here described as young and those described as adults. However, until the organic structures of these barnacles become available for comparison, the fact that unique external scutal structure and parietal ornamentation are identical in both, seem to afford reasonable ground for considering them to represent one variety. The articular furrow also becomes deeper with thicken-

ing of the valve, the pit for the adductor muscle becomes raised in position, and a prominent pit at the rostral corner becomes partly enfolded.

TERGUM. Valves slightly concave, apex acute when not eroded, articular furrow shallow in young specimens, but with growth and thickening of the valve it becomes deeper; marked by several longitudinal, finely grooved ridges. A broad spur is close to the basiscutal angle, about one-fourth or more the height of the valve, it is about one-fourth as wide as the valve, it widens slightly at the end; a shallow spur furrow present. Crests for depressor muscles are few in number, inconspicuous in young specimens but becoming conspicuous in older ones; terga in young specimens vinaceous, the coloration fading with age. Length of tergum in the type specimen is 16 mm. Sculpture of tergum externally is complex; broad, transverse ridges are finely groved and cut by still finer radial grooving.

COMPARTMENTS. Rostrum short and broad, laterals broad, carino-laterals very narrow; radii distinct, moderately wide in young specimens, but in one adult specimen mere lines indicate the junction of the compartments. The parietal tubes are cut into square cells by thin partitions; near the base in older specimens the cells are several layers deep; near the base of one a *Lithophaga* 13 mm. in length was removed. The compartments are very subject to attack by boring organisms. In one young specimen a hole which had been bored entirely through a rostro-lateral, near the top, was mended on the inside by a deposit of white shell substance. The ribbing in young specimens is distinct, white radial lines on a vinaceous ground; some ribs branch and some disappear before reaching the base; on older specimens erosion obscures the ribbing.

ORNAMENTATION OF PARIETES. In older specimens erosion obliterates the very unique ornamentation of the shell, but it is usually present on the new growth near the base. It consists of extremely fine, wavy striæ running horizontally on the surface, about 30 to the millimeter, about every third of a millimeter there is a row of small, whitish beads, averaging about 10 to the millimeter, measured horizontally. On one young specimen about 70 rows of beads were counted. The sheath has roomy hollows beneath; color vinaceous in young specimens but fading in older ones. It has transverse ridges, low on the rostrum, high on the carina, somewhat irregular in contour, those on the carina having the form of narrow plates inclined upward, and grooved on the edges.

BASIS. This is calcareous, strong, with rounded pores. Very fine concentric ridging is visible on the lower side of some specimens.

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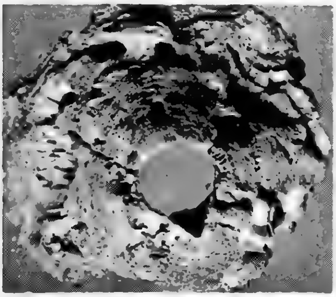

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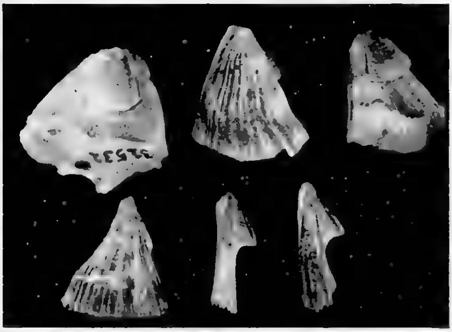

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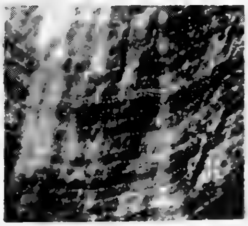

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PLATE 21

Holotype, No. 9434 and paratypes, Nos. 9435, 9436, 9437 (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Loc. 32532 (C.A.S.), from Chamé Point, Canal Zone, Panama; W. D. Clark coll., 1941.

RELATIONSHIPS. *Balanus panamensis,* n. sp., appears to belong to the *Balanus concavus* group. The external sculpture of its scutum is very similar to that of *Balanus concavus glyptopoma* Pilsbry,[1] which was described from the Caloosahatchie, Pliocene of Florida. *Balanus regalis* Pilsbry,[2] a Recent species from Lower California, is illustrated on plate 21 of the same publication. In general appearance it resembles the adult *B. panamensis* although the distinctive ornamentation of the latter is not mentioned as appearing on *B. regalis.*

[1]*Balanus concavus glyptopoma* Pilsbry, U. S. Nat. Mus., Bull. 93, July 31, 1916, p. 102, pl. 21, figs. 2, 3; pl. 22, figs. 2-2c. Caloosahatchie River, Florida. Pliocene.

[2]*Balanus regalis* Pilsbry, U. S. Nat. Mus., Bull. 93, July 31, 1916, p. 108, pl. 21, figs. 4, 4a. "from Point Abreojos, west coast of Lower California."

PLATE 21

FIGS. 1-5. *Balanus panamensis* F. L. Rogers, n. sp.
FIG. 1. Paratype, No. 9435. Young specimen. Vertical view
FIG. 2. Holotype, No. 9434. Vertical view.
FIG. 3. Paratype, No. 9436 (a-f). Compartments of a young specimen.
FIG. 4. Paratype, No. 9435. View showing lines of beads on parietes.
FIG. 5. Paratype, No. 9435. View showing lines of beads enlarged.

PLATE 22

FIGS. 1-8. *Balanus panamensis* F. L. Rogers, n. sp.

FIGS. 1, 3, 4, 7. Paratype, No. 9435. Scutum, figs. 1 (9435a), and 4 (9435b). Tergum, figs. 3 (9435d) and 7 (9435c).

FIGS. 2, 5, 6, 8. Holotype, No. 9434. Scutum, figs. 2 (9434a), and 5 (9434b). Tergum, figs. 6 (9434d) and 8 (9434c).

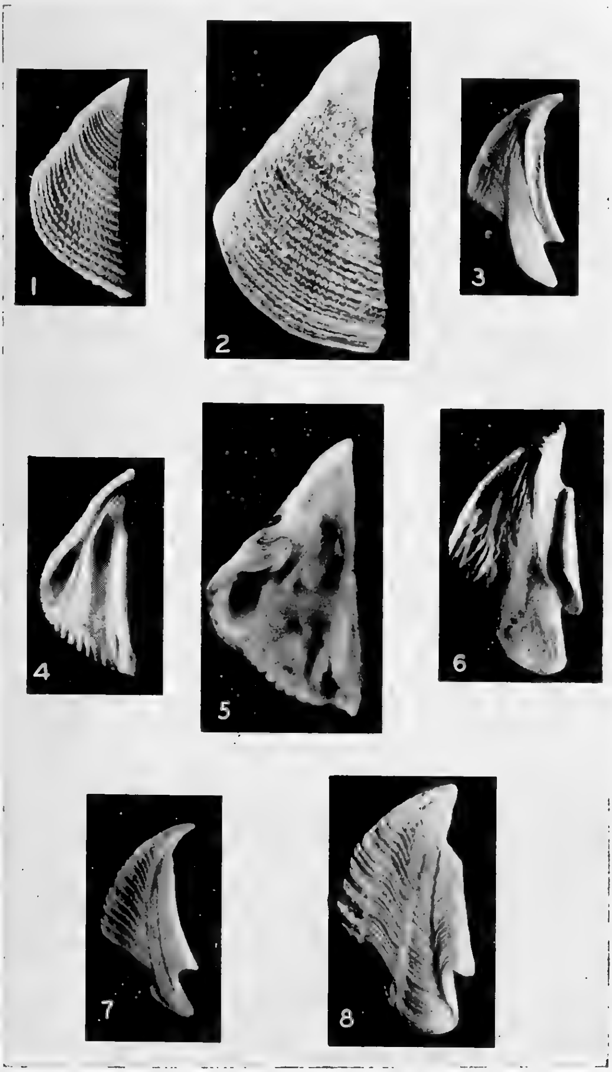

PLATE 22

A NEW AND UNUSUAL HELICOID SNAIL FROM LOS ANGELES COUNTY, CALIFORNIA

By WENDELL O. GREGG, M. D.

A surprise was in store for malacologists when it was learned that a number of species and subspecies which we have been grouping with *Eremarionta,* a subgenus of *Micrarionta,* did not belong to that genus at all, but were more nearly related to the genus *Sonorella.* Anatomically, they were found to lack the dart-sac, mucus glands, and other subordinate structures that would indicate relationship with *Micrarionta* or other Helminthoglyptine snails. For this group, Dr. S. S. Berry (1943) created the genus *Sonorelix,* with *Micrarionta* (*Eremarionta*) *borregoensis* Berry as the type. This group is also characterized by a retiform sculpture of the embryonic shell.

There are two species of land snails in northern Lower California, *Micrarionta, inglesiana* Berry (1928) and *Micrarionta chacei* Willett (1940), which both authors doubtfully referred to the subgenus *Eremarionta.* Dr. Pilsbry (1939) pointed out the resemblance of their apical sculpture to that of *Helminthoglypta.* Recently, the anatomy of *inglesiana* has been studied by Dr. Berry and it was found to belong to *Sonorelix,* with certain distinguishing characters separating it from the typical subgenus. To this subgeneric group, Dr. Berry has given the name *Herpeteros* (1947).

During the past few years, numerous collecting expeditions have been made by the author to various parts of Southern California in search of land mollusks and considerable new material has come to light, including some unusual forms. Of these, the most amazing find was an undescribed species of the subgenus *Herpeterous* from Los Angeles County. It may be known as SONORELIX (HERPETEROS) ANGELUS, n. sp.

Shell helicoid, of moderate size, thin, moderately elevated; whorls 5, convex, gradually increasing to the body whorl which is moderately expanded; the last one-fourth of the body whorl descends moderately so that the aperture lies at a 50 degree angle with the axis of the shell. Base rounded; umbilicus small, one-tenth the maximum diameter of the shell, half covered by the reflected inner lip. Aperture nearly circular, oblique; outer lip slightly reflected, particularly at the base, not appreciably thickened. When viewed with 40x magnification, the embryonic whorl is seen to be covered with somewhat irregular closely-spaced papillæ with a suggestion of transverse arrangement. Incremental wrinkles begin on the second whorl and continue throughout the remainder of the shell. The above mentioned papillæ become sparser until they gradually disappear at the beginning of the fourth whorl. Beginning on the second half of the first whorl,

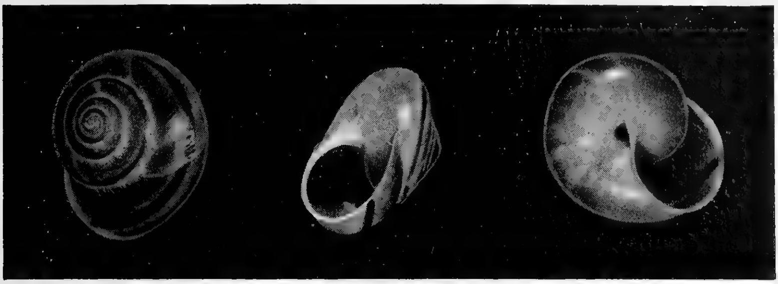

PLATE 23

Sonorelix (Herpeteros) angelus Gregg (Photos courtesy Los Angeles County Museum).

there are, superimposed on the finer papillation, larger elongate papillæ which are widely spaced and arranged both spirally and obliquely. These larger papillæ disappear at the end of the second whorl. On the upper surface of the last two whorls, there are traces of spiral striation. On the inferior surface of the body whorl are faint incremental lines, traces of spiral lines, and a strong papillation about the umbilicus. To the unaided eye, the entire shell has a smooth polished appearance, marked only by incremental lines.

Color light Saccardo's Umber[1] with occasional lighter radial lines marking rest periods. A chestnut band, about one mm. wide encircles the body whorl just above the periphery of the shell and is seen above the suture on the last half of the penultimate whorl. This band is bordered on either side by a somewhat narrower, indistinct band which is lighter in color than the body of the shell.

Max. diameter 20.0 mm., min. diam. 16.8 mm., alt. 13.7, umbilicus 2.0 mm.

Animal: Dorsum of the foot (specimen preserved in alcohol) Neutral Gray; sides of the foot Light Neutral Gray; sole Olive Buff, bordered with Light Neutral Gray; tentacles somewhat darker in color than the dorsum of the foot. The mantle is conspicuously colored with irregular black markings on a white background, thus resembling certain of the *Helminthoglypta.* After drowning, the entire foot was covered with a bright yellow mucus. This dissolved when the dead animal was placed in 25% isopropyl alcohol, leaving the solution brightly colored.

Upon opening the visceral cavity, certain distinguishing characters are noted. There is an absence of dart-sac and mucus glands. A well developed penis retractor muscle is inserted directly upon the apex of the penis. Both spermatothecal diverticulum and epiphalic cæcum are well developed. A large verge fills the cavity of the penis.

[1]Capitalization indicates colors matched with those of Ridgway, Color Standards and Color Nomenclature.

The jaw is strong with six unequal ribs, strongly denticulating the convex margin. The radula has 50-1-50 teeth. The centrals are large with mesocone nearly as long as the basal plate. The laterals are wider. Both centrals and laterals are unicuspid. On the marginals the cusp is split into endocone and mesocone. Further out an ectocone appears.

Type locality: Hillsides on north side of the west end of Soledad Canyon, Los Angeles County, Calif. All specimens were taken during the months of February and March, 1947. They were found under dead yuccas (*Hesperoyucca whipplei*). They were found over a narrow area about 2.7 miles in length between points 1.2 and 3.9 miles from Solemint (western junction Soledad Canyon road with Mint Canyon Highway). All specimens found within 300 yards of the canyon floor. Altitude about 1,700 feet.

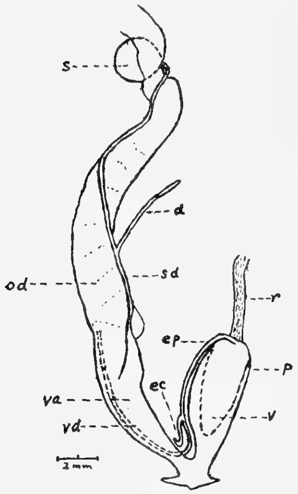

PLATE 24

Sonorelix (*Herpeteros*) *angelus* Gregg, anterior part of hermaphrodite system (*d*, spermatothecal diverticulum; *ec*, epiphallic cæcum; *ep*, epiphallus; *od*, oviduct; *p*, penis; *r*, penis retractor; *s*, spermatotheca; *sd*, duct of spermatotheca; *v*, verge; *va*, vagina; *vd*, vas deferens).

The type No. 3692a, author's collection. Paratypes in collections of Los Angeles County Museum (No. 1085), Dr. S. S. Berry (No. 14582), M. L. Walton, and the author (Nos. 3645, 3666, 3683, 3685, and 3692).

The anatomical characters together with the shell characters definitely place this snail in the subgenus *Herpeteros*. *S. angelus* is distinguished from *S. chacei* (*Micrarionta chacei* Willett, 1940) by its somewhat smaller size, less strongly descending body whorl, and by its half covered umbilicus. In *S. chacei* the umbilicus is completely covered. *S. inglesiana* is much flatter and the umbilicus is not covered.

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A NEW SPECIES OF *AMBRYSUS* FROM DEATH VALLEY, WITH NOTES ON THE GENUS IN THE UNITED STATES (HEMIPTERA: NAUCORIDÆ)

IRA LA RIVERS
University of California, Berkeley

NAUCORIDÆ (Fallen) 1814

AMBRYSINÆ Usinger 1941

Ambrysus Stål 1862

AMBRYSUS FUNEBRIS sp. nov.

General appearance: the smallest, most compact species known to me—size 6.0-6.5 mm. long and 3.5 mm. wide. Dorsum conspicuously lighter anteriorly than posteriorly, unmottled, shiny. Venter deep yellowish with conspicuous darkening centrally.

Head: smooth, shiny, minutely punctulate. Color light yellowish in anterior two-thirds, brownish in posterior portion behind eyes; two unequally spaced dark, blackish sinuosities occupy centrum, and between them, the very faint line of light brownish dots, increasing in size posteriorly, so characteristic an *Ambrysus* pattern, is barely discernible, fusing with the brownish posterior portion of head (which latter represents the "bilobed" basal spot of other species); some darkening at anterior margin of head also. When oriented so that dorsal plane is perpendicular to line-of-vision (i.e., the greatest amount of dorsum exposed to view), front of head is seen to be slightly protuberant before eyes, and distinctly truncate. Eyes coal-black; outer margin slightly curved, inner margin straight, posterior margin strongly curved; viewed posteriorly, eyes very distinctly, but not exceptionally strongly, protuberant above general head surface, the point of juncture forming a prominent sinuosity. Head broadly and deeply set into anterior pronotal border. Labrum same color as front of head; ratio of length-to-width, 15::29 (50%); mouthparts darkening at tip.

Head ratios are:

1) total length to width (including eyes), 75::107 (70%);

2) anterior distance between eyes to posterior distance, 51::72 (71%);

3) posterior distance between eyes to greatest length of head posterior to this line, 72::28 (39%).

Pronotum: shiny, smooth, minutely punctulate with incipient transverse rugulosities developing centrally behind region of deepest head penetration. Color whitish-yellow laterally and posteriorly, brownish on disc with some brownish dotting laterally; central "V"-shaped area still detectable, with remnants of the two large, oblong brownish spots so characteristic of the *Ambrysus* pattern; thin, blackish, posterior, transverse pronotal line very distinct, separating the darker disc from the whitish, broad posterior pronotal border; two blackish, semi-lunar spots present in antero-lateral area of pronotal disc. Lateral pronotal margins smooth, unserrate, but rather conspicuously, although sparsely, pilose. Per cent of lateral curvature, expressed in terms of straight-line distance between anterior and posterior lateral angles and greatest vertical distance between this base line and line-of-curvature, is 16% (102::16). Postero-lateral angles well-rounded. Venter generally yellowish-brown, lightening laterally, with some darkening medially and along posterior border; conspicuous pilosity along posterior margin and on keel.

Dorsal pronotal ratios are:

1) width between anterior angles to greatest pronotal width, 70::118 (59%);

2) median length to greatest width, 44::118 (37%);

3) width between anterior angles to distance between anterior angle and posterior base of pronotum, 70::67 (96%).

Scutellum: dark brownish-black with some lightening laterally. Shiny but not polished, shagreened with dense, shallow punctation, each puncture the seat of a white spot. In normal position, i.e., approximately on a plane surface with remainder of body, ratio of three side, anterior and two laterals, is 114::80::79.

Hemelytra: brownish-black with some vague, diffuse lightening to brownish at posterior end of clavus, and behind embolium, which latter bears the only light yellow spotting of the entire pattern. Surface shiny but not polished, shagreened as is scutellum. Embolium approximately of average proportions for the genus (length-to-width, 102::32=32%; the proportions of embolium in this species are difficult to judge, since the posterior bordering line, usually well-developed, is nearly absent, and the caudal limits must be approximated by the position of the wing sinuosity which usually marks the lateral terminus of the line), sparse but conspicuous marginal pilosity present; anterior three-fourths light yellow, posterior one-fourth and inner emboliar edge for most of its distance brownish. Hemelytra rather weakly exposing lateral connexival margins, which are light yellow with some darkening at connexival junctures; marginal pilosity conspicuous. Postero-

lateral connexival angles non-spinose, but slightly angulate-produced in posterior segments. Hemelytra not quite attaining abdominal tip.

Venter: the prothoracic venter has been discussed above. Remainder of venter yellow-brown, abdomen covered with dense, short, golden hydrofuge pelt, largely lacking over meso- and metasterna; mesosternum with blackish along anterior border and centrally. Emboliar venter distinctly longitudinally bicolored, whitish exteriorly, yellowish interiorly. Connexival postero-lateral angles completely non-spinose, and developing in size and angulosity from anterior-to-posterior; angles of segment I quite completely smoothed into the general body marginal contour; angles of II minutely and shortly, bluntly, angulate-produced, hardly breaking out of the general smoothness of the lateral contour; angles of II distinctly and more strongly, but still bluntly, angulate-produced, while angles of IV are the ultimate in size and angulosity (in the ♂ ; angle V is largest in the ♀), but still not greatly larger than III. Connexival margins smooth, unserrate; borders about medium in width, subparallel over most of their lengths. Female subgenital plate simply and moderately concave at apex. Male genital process entirely lacking.

Legs: (prolegs)—coxa elongate, somewhat angularly globular, whitish-yellow, smooth, flattened to receive heel of femur, distal edges distinctly darker. Trochanter well-developed, smooth, shiny, same color as coxa, with a tuft of hairs distally on anterior end. Femur smooth, whitish-yellow, polished, widest near proximal end, narrowing rapidly to distal end (i.e., with the characteristic swollen, incrassate appearance), compressed dorso-ventrally, with typical short, dense mat of hair along front border which serves as a resting groove for tibia when closed against femur; ratio of length to greatest width of ventral surface is 97::59 (61%). Tibia long, slender, smooth, deep amber, darkening apically, curved most strongly in distal part where, with the single tarsal segment, it forms a continuous curved, grasping instrument—combined tibia + tarsus, when closed, distinctly and strongly exceeding adjacent (proximal) end of femur. Tarsus darkening at tip.

(Mesolegs)—coxa long, somewhat angularly globular, yellowish, equipped with short, dense pile, slightly curved from posterior end weakly to anterior end, the outer face flat for reception of basal part of femur. Trochanter large, distinct, same color as coxa, smooth distally, pilose proximally. Femur long, narrow, whitish-yellow, compressed dorso-ventrally, weak and sparse setulosity on outer or anterior edge; a row of short, reddish chitinous points on dorso-internal (dorso-posterior) margin—ratio of length to median width of ventral surface is 90::17 (19%), length 1.40 mm. Tibia same color as femur, smooth, shiny, long, narrow,

bristling with yellowish and reddish spines arranged in four longitudinal rows representing the four weak "corners" of tibia; ventro-internal (ventro--posterior) row of spines consisting of strong reddish spines alternating with weak yellow spines (rather than the usual condition for the genus in which single spines alternate with short rows of transverse spines along this border); distal end ventrally with two prominent, transverse rows of spines, the terminal row set solidly across tibial apex, the secondary or proximal row essentially complete to outer or anterior edge—ratio of length to median width of ventral surface is 76::8 (11%), length 1.25 mm. Tarsus smooth, long, narrow, whitish-yellow at base, blackening toward tip, pilose and setulose ventrally; two-segmented, terminating in two slender, amber claws, darkening at tips and rather strongly curved.

(Metalegs)—coxa swollen, globular, whitish-yellow, well-furred with short, dense pile, flattened ventro-laterally for reception of basal part of femur. Trochanter well-developed, same color as coxa, pilose proximally, smooth and shiny distally. Femur long, narrow, smooth, whitish-yellow, dorso-ventrally compressed; prominent, short, reddish spination on outer (anterior) margin; inner (posterior) margin with a row of reddish chitinous points dorsally and ventrally, the latter accompanied, and rather obscured, by a row of dense, short pile—ratio of length to median width is 108::19 (18%), length 1.75 mm. Tibia long, narrow, shiny, same color as femur, armed with four rows of reddish spines, the rows more-or-less equally spaced about tibial circumference; a mat of dense, long hairs occupying inner (posterior) face—distal end ventrally with two prominent, transverse rows of spines, the terminal row set solidly across tibial apex, the secondary or proximal row essentially complete to outer or anterior edge—ratio of length to median width of ventral surface, is 123::13 (11%), length 2.0 mm. Tarsus smooth, long, whitish at base, blackening toward tip; two-segmented, spinose and pilose ventrally, terminating in two slender, amber claws, darkening at tips and rather strongly curved.

Type locality data: CALIFORNIA—Death Valley (Inyo County) (Cow Creek, 3 mi. E. Death Valley National Monument Winter Headquarters (Funeral Range), 4(iii)48, R. Coleman;[1] 19(vi)48, LaR & Coleman, el. approx, 1,000 ft.).

Disposition of types: Holotype male (No. 5946), allotype (No. 5947) and four paratypes in California Academy of Sciences, San Francisco; paratypes in the collections of Robert L. Usinger (Berkeley, California); Snow Museum, University of

[1] I am indebted to Mr. Richard Coleman, of San Francisco, an assiduous collector, for the first specimen ever taken of this species, as well as for aid in procuring the subsequent large series upon which the description is based.

Kansas, Lawrence; U. S. National Museum, Washington, D. C.; American Museum of Natural History, New York City; British Museum (Natural History), London; Paris Museum, Paris; Death Valley National Monument, California; and the writer (Reno, Nevada).

Ecologic data: A. funebris is known only from the type locality, Cow Creek, which is a short, narrow, rather swift, warm, slightly mineralized stream originating in the western foothills of the Funeral Range on the eastern side of Death Valley. Its point of origin is on a low plateau overlooking the Navares' place three miles east of the valley floor, and consists of several small springs which converge into a single stream which then descends the 45° travertine slope and flows swiftly in a straight line for approximately a hundred yards and is ultimately channeled into a pipe line for the Death Valley National Monument Winter Headquarters three miles below. *Ambrysus funebris* was found only between the base of the low travertine slope and the Navares' cabin nearly a hundred yards downstream, and in suitable spots, very abundantly. Collecting made it immediately apparent that the species was quite particular in its preferences, occurring in only one of the three distinct bottom types prevalent in the stream. Where the stream flow was swift enough to keep the bottom swept clear of sand and coarse gravel fragments, or slow enough to allow an accumulation of fine sand, *A. funebris* was absent—only where the flow was intermediate, strong enough to eliminate sand but too weak to move coarse gravel, was the species found, and then in large numbers, crawling about among the gravel. They are tenacious crawlers, and seem little troubled by the comparatively swift water; although they swim readily in still water (when kept in an aquarium), they seemed never to swim in Cow Creek, being helpless against the flow of water, but depended entirely upon crawling to move about.

The vast majority of the sixty-odd specimens collected were adults, only a few immatures coming to hand.

Water temperature, in the region inhabited by the species, varied from 36°C to 35.5°C, being 40° at the source on the nearby plateau. Associate animals seemed few in variety, but considerable in numbers and consisted chiefly of gomphines and coenagrines. Taken commonly along shore was the gelastocorid *Mononyx fuscipes* Guerin 1843.

This peculiar little *Ambrysus,* the smallest of the genus in the United States, may be compared with such species occurring around it and with which it might conceivably be confused, by the following key:

1. Lateral (connexival) edges of abdominal segments III-IV uniformly and distinctly serrate in contrast to the absolutely smooth edges of segments I-II........................*pudicus* Stål 1862

———Abdominal edges not as above; if serrate, the serration is gradually developed anteriorly-to-posteriorly........................2

2 (1). Male completely lacking a genital process[2] (female with tip of subgenital plate simply concave)................*funebris* sp. nov.

———Male always with a well-developed genital process............3

3 (2). Tip of female subgenital plate dominantly concave, either simply or complexly so......................*mormon* Montandon 1909

———Subgenital plate apically more-or-less truncate-to-multisinuate, but never with a dominant concavity..........................4

4 (3). Female subgenital plate strongly trifid at apex, the lateral angles sharp, the central "angle" or process more rounded; male genital process comparatively sharply right-angulate, narrowing to tip ....*woodburyi* Usinger 1946

———Female subgenital plate either truncate or quadrisinuate apically; male process not suggestively right-angulate..................5

5 (4). Postero-lateral connexival angles non-spinose, merely somewhat angulate-produced..................*californicus* Montandon 1897

———Postero-lateral connexival angles strongly and conspicuously spined ....*bohartorum* Usinger 1946

Such other species as *A. puncticollis, A. melanopterus, A. guttatipennis* and *A. signoreti,* which have been recorded from Arizona and southern California, are large and generally robust, no individuals of which, to my knowledge, are ever less than 10 mm. in length. *A. mormon,* the most variable and widespread species, is generally quite large and robust, but some of its thermally-adapted ecads (such as *A. m. heidemanni* Montandon 1910), may become reduced to 8 mm. in size. Very small individuals of *A. californicus* bear the closest superficial resemblance to *A. funebris,* but are easily separated on structural characters. *A. pudicus* very probably does not occur within the immediate area surrounding *A. funebris,* indications now being that United States records for the former species are erroneous. With *A. pudicus* probably eliminated from the picture, *A. funebris* stands apart sharply from all known United States *Ambrysi* as being the only species in which the male genital process is completely lacking, its point of origin being merely a rounded angle.

The early literature on *Ambrysus* in our northern quartersphere is replete with misidentifications. The eminent American hemipterist, Uhler, is the source of most of these early records, and it is evident that his conception of *Ambrysus* was quite at variance with what we now know of the group.[3] Such is attested

[2]The male genital process is a thin chitinous flap arising, when present, on the caudal edge of tergite,V, slightly to the right of the median line.

[3]An interesting sidelight on the early conception of the Naucoridæ is evidenced by Uhler's use of this family name for the belostomatidæ *Abedus ovatus* and *Belostoma fusciventris* (then in *Zaitha*) (1875).

by his recording of *A. pudicus* from Baja California, where it has never since been found; there is little doubt he was confusing *A. pudicus* with the then undescribed *A. hungerfordi* Usinger 1946 which is quite distinct as we recognize it today, even though superficially resembling *A. pudicus.*

The United States *Ambrysi* are, rather peculiarly, restricted to the western, mountainous half of the country, giving way to *Pelocoris* in the East. After entering Texas from Mexico, the easternmost known records of *Ambrysus* are from the vicinity of the Balcones Escarpment on the south and east face of the Edwards Plateau, and no records are known from the flat, semi-tropical environs between the escarpment and the Gulf of Mexico, an area presumably dominated by *Pelocoris.* The latter then swings east and north to cover the United States east of the Rockies. The finding of a single new species of *Pelocoris* from the Great Basin (La Rivers MS), over a thousand miles west of its nearest known relatives, does not invalidate the East-*Pelocoris,* West-*Ambrysus* concept since no *Ambrysi* seem to occur beyond the mountainous West.

The tropical nature of the genus is hardly in doubt on the basis of its present preferences and population and species climaxes, and it can be suspected that low temperatures may be the limiting factor in its northward spread, particularly in view of the facts that (1) the northernmost record (Yellowstone) is from thermal waters, and that (2) the most widely distributed species, *A. mormon,* found from the Rockies to the Pacific (from northern California to southwestern South Dakota and south to southern California, Arizona and New Mexico), from nearly sea level to approximately 8,000 feet in elevation and in waters varying from swift, pure mountain streams to quiet, brackish lake waters, is an extremely variable species with two recognized subspecies and numerous un-named ecads. The significance of *A. mormon* in this respect lies in the fact that, as the most variable species, it is also the one which has penetrated farthest to the north. Apparently then, an increase in its tolerance ranges for low temperatures over the tolerances of the group as a whole has been of considerable advantage to it, and other species, lacking such variability, have been kept farther to the south. *A. bohartorum,* a northern affiliate of the southern California *A. californicus,* has managed to penetrate the coastal fog belt into northern California, in an environment much ameliorated over that which prevails a short distance inland, where low temperatures would presumably prove restrictive to it.

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THE FLEA GENUS RHYNCHOPSYLLUS IN THE UNITED STATES (SIPHONAPTERA: HECTOPSYLLIDÆ)

By G. F. AUGUSTSON[1] AND LLOYD C. RYAN[2]

Among the many interesting ectoparasites received by the authors for identification during the past few years from various private collectors and through the courtesy of the Los Angeles County Museum, are a small number of fleas collected from bats in Texas. Thorough study of this material proved that they belong to the genus *Rhynchopsyllus* Haller, which previously has never been reported from the United States.

All fleas in this small series were collected in Texas off the Mexican Free-tail bat, *Tadarida mexicana.* In 1944 J. C. Couffer obtained five specimens from bats in the Ney Cave, Medina County, and two years later, D. G. Constantine took a single female from a bat in the Frio Cave, Uvalde County. Unfortunately like most "stick-tight" fleas, these specimens are in a badly mutilated condition; however, there is little doubt that they are *Rhynchopsyllus pulex* Haller, a common parasite of various South American bats.

It is of interest to note that until recent years *R. pulex* was assigned to the genus *Hectopsylla* Frauenfeld. Jordan and Rothschild (1906) clearly recognized (pg. 63) that *H. pulex* differed from other members of the genus in possessing a distinctly rounded frons instead of angulate, and that the maxilla are long and pointed backward instead of short and straight, or pointed slightly forward. Jordan (1942, pg. 405) again indicated *Rhynchopsyllus* as a valid genus,, adding that in females the orifice of the spermatheca is located on a projection away from the body of this organ, whereas in typical *Hectopsylla* it is flush with the normal outline. Following this arrangement, da Costa Lima (1943) listed both genera separately in his key to Brazilian fleas.

In camparison with known United States *Hectopsylla,* as reported by Augustson (1944), female specimens of *R. pulex* are readily separated from *H. psittaci* on the three generic differences noted in the above discussion. It is unfortunate that as yet only females have been collected in both genera from the United States. These new records do, however, bring to a total of three the known genera representing the Family Hectopsyllidæ within this country. The following key not only identifies each genus, but, to date, each known species from the United States.

[1]Manager, Madera County Mosquito Abatement District, Madera, Calif.
[2]University of Southern California, Los Angeles, California.

FAMILY HECTOPSYLLIDÆ

(Females only)

1. Head with frons distinctly angulate, spermatheca orifice not on a projection 2
   Head with frons evenly rounded, spermatheca orifice placed on a projection........................*Rhynchopsyllus* Haller 1880 (pulex)

2. Body of spermatheca not enlarged, fed specimens with abdominal tergites and sternites widely separated.. *Hectopsylla* Frauenfeld 1860 (*psittaci*)
   Body of spermatheca greatly enlarged, abdominal tergites and sternites not widely separated in fed specimens.. *Echidnophaga* Olliff 1886 (*gallinacea*)

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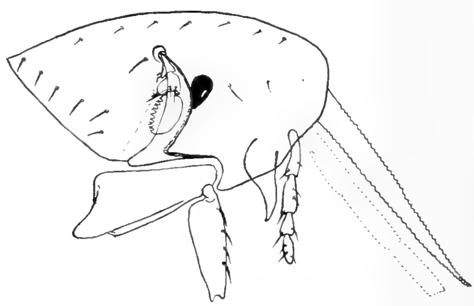

PLATE 25
Rhynchopsyllus pulex Haller
Head and coxa I, female

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Subscription—$2.00 per year

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Bulletin, Southern California Academy of Sciences

Vol. XLVII, 1948

INDEX OF SUBJECTS

New varieties and species in **bold face type.**

INDEX OF AUTHORS

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BULLETIN OF THE

Southern California Academy of Sciences

LOS ANGELES, CALIFORNIA

VOL. XLVIII JANUARY-APRIL, 1949 PART 1

CONTENTS

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Bulletin, Southern California Academy of Sciences

VOLUME 48 - - - - - - PART 1, 1949

STUDIES IN ARIZONA LEPIDOPTERA

I. A NEW SUBSPECIES OF *SPEYERIA ATLANTIS* (EDWARDS) FROM THE KAIBAB PLATEAU, GRAND CANYON NATIONAL PARK.

By JOHN S. GARTH
Allan Hancock Foundation, The University of Southern California

Significant progress toward the elucidation of the Great Basin and Rocky Mountain distribution of *Speyeria atlantis* (W. H. Edwards) (1863, p. 54) has been made recently by Dos Passos and Grey (1945, 1947). However, the existence on the Kaibab Plateau of northern Arizona of an isolated colony exhibiting constant differences in size and maculation from the presently recognized races of this polytypic species has apparently escaped attention. As a result of field work conducted by the Allan Hancock Foundation at the North Rim of the Grand Canyon in the summer months of 1946 and 1947, a sufficient series has been accumulated to permit its description.

SPEYERIA ATLANTIS SCHELLBACHI, new subspecies

Figures 1-4

Description: Above, similar to *S. atlantis chitone* (W. H. Edwards) (1879, p. 82), but with a more ruddy color and more heavily and diffusely patterned throughout. This is especially apparent in the basal suffusion, which tends to obscure the broadened band, and in the black scaling along the veins, which widens perceptibly inside the extradiscal row of round spots.

Below, both sexes approaching *S. atlantis nausicaa* (W. H. Edwards) (1874, p. 104), heavily silvered with occasional partially silvered specimens, the silver spots tending to elongate, all spots edged above with black; ground color of secondaries cinnamon to violet brown mottled with buff, the narrowed submarginal belt remaining buff instead of yellow.

Expanse: Males 54-61 mm. (holytype 61 mm.). Females 52-66 mm. (allotype 66 mm.).

Type material: Male holotype, AHF No. 471, and female allotype, AHF No. 471a, from Neal Spring, North Rim, Grand Canyon National Park, Coconino County, Arizona, 8,175 feet,

July 5, 1947, collected by John S. Garth, Allan Hancock Foundation survey party. Twenty paratypes as follows: 1 female, North Rim, Grand Canyon, July 29, 1939, Louis Schellbach, collector; 1 female, North Rim, Grand Canyon, August 19, 1942, H. C. Bryant, collector; 1 male, 1 female, Two River Junction, North Rim, Grand Canyon, July 28, 1945, Louis Schellbach, collector, the preceding four paratypes on loan from the Naturalist Workshop, Grand Canyon National Park; 1 male, 1 female, Neal Spring, North Rim, Grand Canyon, August 16, 1946, J. S. Garth, collector; 2 females, Kanabownits Spring, North Rim, Grand Canyon, August 22, 1946, J. S. Garth, collector; 7 males, 2 females, Neal Spring, North Rim, Grand Canyon, July 5 to 18, 1947, J. S. Garth, collector; 1 male, Robbers' Roost Spring, North Rim, Grand Canyon, July 10, 1947, J. S. Garth, collector; 2 females, Swamp Lake and Swamp Ridge, North Rim, Grand Canyon, July 12 and 14, 1947, J. S. Garth, collector.

The holotype, allotype, and ten paratypes are in the collection of the Allan Hancock Foundation, the University of Southern California. The remaining paratypes will be distributed as follows: one male and three females to the Naturalist Workshop, Grand Canyon National Park, one pair each to the United States National Museum, the American Museum of Natural History, and the Los Angeles County Museum.

Remarks: The proposed new race of *Speyeria* has been variously determined by competent authorities on the basis of single specimens submitted by park naturalist Louis Schellbach: as "*Speyeria* sp. close to *chitone*" by W. D. Field, and as *Argynnis nausicaa* by J. A. Comstock, both currently recognized as subspecies of *S. atlantis*. The status of *chitone* has been clarified by Dos Passos and Grey (1947, p. 19) with the fixation of Cedar Breaks National Monument, Utah, as type locality, thereby eliminating Arizona from the originally designated range. Similarly, the type locality of *nausicaa* has been fixed, although not without a question mark, as Cochise County, in the southeastern part of Arizona. The same authors have ably defended the designation as racial entities of homogeneous colonies illustrating transition between dissimilar forms. In the light of this reasoning *schellbachi* may be considered as linking *chitone* and *nausicaa*, although geographically isolated from either.

The study of the newly proposed race has been facilitated by a series of 7 male and 8 female specimens of *chitone* from Cedar Breaks, Utah, collected by J. A. Comstock, and by a much longer series of *nausicaa* from the White Mountains of Arizona, collected by E. Yale Dawson. Pertinent to the study were topotypes of the following races of *atlantis:* of *nikias* (Ehrmann) (1917, p. 55), *wasatchia* Dos Passos and Grey (1945, p. 9), and *dorothea* Moeck (1947, p. 73) in the collection of the Los Angeles County

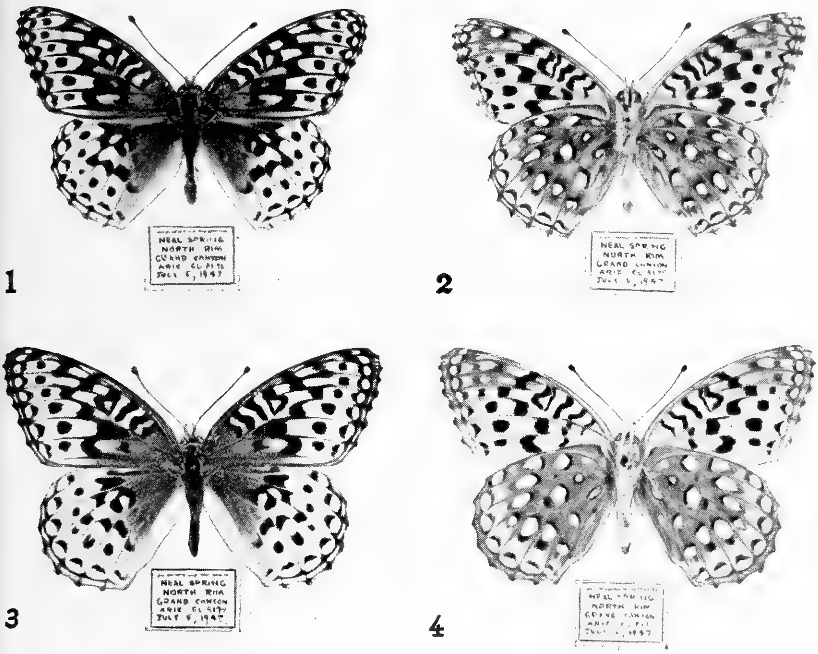

PLATE 1

SPEYERIA ATLANTIS SCHELLBACHI, new subspecies

FIG. 1. Holotype male, upper surface, x .78.
FIG. 2. Holotype male, under surface, x .78.
FIG. 3. Allotype female, upper surface, x .7.
FIG. 4. Allotype female, under surface, x .7.

Museum, and of *tetonia* and *viola* Dos Passos and Grey (1945, pp. 9, 10) in the collection of the Allan Hancock Foundation.

I take pleasure in naming the new subspecies for Louis Schellbach, III, park naturalist, whose enthusiasm as a collector has resulted in acquainting specialists in many fields with the novel and interesting forms to be found within Grand Canyon National Park.

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A NOTE ON *CAICELLA MYSIE* (Dyar) WITH A FIGURE OF THE MALE GENITALIA

By J. W. Tilden

Caicella mysie (Dyar) was described in 1904 from two specimens, the holotype and a paratype, taken by Oslar in the Patagonia Mountains, Arizona. It would appear to be a rare or at least a seldom collected species. Part of this may be due to the rather isolated range. In any case, little information seems available beyond the original description, and the genitalia of the male seem never to have been figured. A male specimen taken in the type locality by the author on August 1, 1940, is figured by means of a photomicrograph of the slide of the male genitalia in the accompanying illustration, and for completeness, the insect itself is also figured, since it differs in certain respects from the type.

The present specimen was kindly compared with the type by Mr. W. D. Field of the United States National Museum, and he states that the hyaline spot in the outer third of the cell is broad in the type, completely crossing the cell on both surfaces. In the present specimen this spot is smaller, and is confined to the upper half of the cell, as can be seen by the photograph. Mr. Field also compared the photomicrograph of the male genitalia with the slide made from the male paratype of *mysie,* and considers them to be conspecific. Thus it would appear that there can be little doubt but what the individual that is figured in this article is of

the same species as the two specimens that Dyar had before him when he wrote his description of *mysie*.

Lists and revisions of the Hesperiidæ written since the description of *mysie* have had little to add to known information because of lack of material. Dyar himself placed the species in the genus *Thorybes*, but called attention to the similarity to *Phœdinus caicus* (Herr.-Schaef.). Skinner (1911) in his discussion of certain North American Hesperiidæ, placed *mysie* as *Eudamus* (*Phœdinus*) *mysie*, merely repeating Dyar's original description.

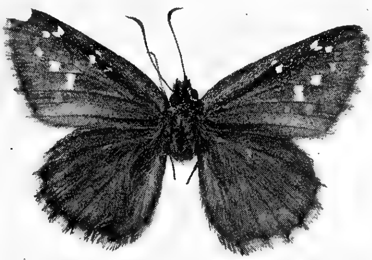

PLATE 2

Caicella mysie (Dyar), upper surface. Patagonia, Ariz., August 1, 1940. (topotype).

Skinner and Williams (1922) in their important paper on the genitalia of North American Hesperiidæ, list the species as *Cogia* (*Phœdinus*) *mysie*, and state that "this species is not represented in the Academy collection and we are not familiar with it." They do not figure it. Note, however, the emended spelling, *Phœdinus*.

Lindsey (1921) did not have this species at hand when he wrote "Hesperiodea of America North of Mexico." Lindsey, Bell & Williams (1931) state that they "do not know this species." In 1934, Heming proposed *Caicella* as a new name for *Phœdinus* God. & Salv., which is preoccupied in Coleoptera (Cerambycidæ). Bell (1938) lists the species under its present name of *Caicella mysie*.

These appear to be the major references to this species in American literature, which seems to have been known mostly if not entirely from the type material.

As will be noted, the genitalia of *mysie* differ in many details from those of *caicus* as illustrated by Lindsey, Bell & Williams (1931, Plate VII, fig. 3). In *mysie* the tegumen is larger and more hood-like; the articulation of the valves of harpes with the

vinculum is marked by a raised condyle on the vinculum; the saccus is shorter, the distal end of the harpe is more rounded, less projecting, and while it has a blunt upturned point, is unarmed; most diagnostic of all, the ædeagus has but a single internal spicule.

The author is indebted to Mr. W. D. Field for his kindness in comparing the material with the type, and to Mr. Lester Brubaker of San Jose State College for making the photographs.

PLATE 3

Male genitalia, *Caicella mysie* (Dyar) Topotypical male, Patagonia, Ariz., August 1, 1940.

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SOUTHWESTERN GEOMETRID NOTES AND NEW SPECIES

By JOHN L. SPERRY
Riverside, California

Semiothisa fieldi Swett was described in 1916 (Can. Ent. p. 326) from a series of specimens taken in the La Puerta Valley of southern California in July. This is a light ashen gray insect, with prominent t.a. and t.p. lines and an annulate discal spot on the primaries. In the collection of the Los Angeles County Museum there is a short series of a much lighter insect, taken at Independence, Calif. by Dr. John A. Comstock in April and May, which seems to be sufficiently stable and different from topotypical *fieldi* to warrant a varietal name.

SEMIOTHISA FIELDI var. COMSTOCKI var. n.

Palpi, head, legs, thorax and ground color of wings light tilleul buff (Ridgway color); maculation, Hay's brown. Compared with *fieldi* Swett the t.a. line has a tendency to curve inward from the upper edge of the cell and although very faint above that point, in some specimens almost reaches the costa. In *fieldi* the line is heavy and stops at the cell. The t.p. line is heavy in both insects but in *comstocki* there is a narrow, smooth gray line separating the line from the distad shade and there is a smooth wide band of lighter scales following that shade. In *fieldi* these light lines are usually absent but when present are rough and irregular. The annulate discal spots in *fieldi* are distinct, in *comstocki* very faint.

Beneath, *fieldi* is darker and more heavily irrorate. *Comstocki* has a distinct tendency toward albinism, in two specimens of the type series the maculation is merely indicated. Expanse nearly identical, 20-22 mm.

There are slight but constant differences in the male genitalia which may indicate that these are separate species but that problem must wait their breeding. The outer central section of the valve connecting the costa with the sacculus, in *fieldi,* leaves the costa in a smooth, deep curve and makes a central rounded projection before going to the sacculus, in *comstocki* this leaves the costa at an angle and goes to a point before angling to the sacculus. The octivals are pointed in *comstocki* and rounded in *fieldi,* the excavation in *comstocki* is shallow and broad, in *fieldi* deep and moderate and the plate in *fieldi* is narrow and long (al-

most 2 mm.) and in *comstocki* short and squat (less than 1½ mm.).

Holotype male, Independence, California June 8, 1938 (Dr. J. A. Comstock. coll.) in the collection of the Los Angeles County Museum.

Allotype female same data, May 14, 1936 and in the collection of Grace H. and John L. Sperry.

Paratypes 4 males, 1 female, same data, April 14 to May 14; 1 female Lone Pine, Calif. June 22, 1937 (Dr. J. A. Comstock, coll.); 1 male, Cartago, Calif. July 2, 1940 (C. Henne) and in the collection of the Los Angeles County Museum and the Sperry collection.

It gives me great pleasure to name this beautiful insect in honor of our friend Dr. John A. Comstock, on his retirement from the Los Angeles Museum, as a slight token of the esteem in which we hold him and with the hope that increasing leisure may find his tent more often pitched in the pleasant places.

Among the many interesting geometrids taken by the Martins and Dr. Comstock in the Santa Rita Mountains of Arizona in 1947 there was a good series of a well marked species of *Nepterotæa,* McD. As *N. diagonalis* Cass. is missing from the Sperry collection it was again necessary to impose on the good nature of our friend, Dr. Nathan Banks for comparison with the type in the Museum of Comparative Zoology and through his kindness the author is enabled to describe

NEPTEROTÆ DOROTHEATA, sp. n.

The ground color of legs, abdomen, thorax and wings is an ecru drab, formed by an admixture of light gray and dark brown scales, the depth of color depending on the percentage of brown scales. Palpi short, porrect, heavily scaled in dark brown. Front light over clypeus with broad black-brown band filling the center of the front between the eyes, upper quarter and vertex of the ground color. Male antennæ dark brown, moderately pectinated, apex dentate, female antennæ very shortly pectinate, color the same. Maculation black brown.

Primaries: T.a. line narrow, from costa at ¼ out at right angles, diffuse to middle of cell, thence narrowing to a hair line angles sharply back to inner margin 1/5 out from the base. A weak median line from slightly beyond mid costa curves out and inward through the distinct, round, black discal dot, thence subparallel to t.a. line to inner margin at ½; t.p. line diffuse, irregular, heavier than the other lines starts at ¾ out on costa at right angles, goes to vein 7 forming a sharp outward tooth at that point

thence curving back to within a mm. of the median line and parallel thereto to inner margin. There is a short triangular dash on the costa halfway between the t.p. line and the apex. In some specimens there is a very light hair line parallel to and distad about ½ mm. from the t.p. line. There are three or four irregular dark dashes above vein 4, parallel to and between the veins in the subterminal area. There is an irregular, dark, broken terminal line interrupted at the veins. Fringes of ground color, slightly darkened at ends of veins.

Secondaries: Variable, t.a. line usually indicated or present from end of t.a. on primaries curving across wing to inner margin at 2/5. T.p. line continues from primaries, curves close outside distinct discal dot and reaches inner margin 1 mm. beyond t.a. line. There are usually indications of two dim subparallel lines beyond the t.p. line, a scalloped terminal line, fringes as in primaries. The ground color of the wings in the female is darker than in the male.

Beneath: Ground color is much lighter, in some specimens almost white, discal dots present on all wings, usually immaculate, there is sometimes indication of the maculation of the upper side along the costa. Expanse both sexes, 20-22 mm.

This species appears closest to *obliviscata* B. & McD. is about the same size and flies in the same part of Arizona but is distinguished from that species by the definite maculation. The male genitalia is markedly different, the harpe in *obliviscata* consisting of a bunch of a dozen or more heavily curved subequal spines whereas that of *dorotheata* is made up of a single long, heavy curved spine backed by two or three shorter spines. The ædeagus in *obliviscata* is armed ventrally at the apex with a single short spine and that of *dorotheata* is simple. The maculation separates *dorotheata* from *memoriata.* Pears, and *polingi* Cass. and Dr. Banks writes that "the type specimen of *diagonalis* Cass. is but little marked, the black dot, and beyond the oblique line is faint, the fore wing is narrower and longer, the black terminal line is continuously black, not interrupted. Beneath, the fore wing is plainly darker than the hind wing." *Dorotheata* should be placed in the genus between *obliviscata* B. & McD. and *memoriata* Pears.

Holotype male Madera Canyon, Santa Rita Mts., Ariz., Aug. 2, 1947 (Dr. J. A. Comstock and Lloyd M. Martin) and in the collection of the Los Angeles County Museum.

Allotype female same data, July 24, 1947 and in the collection of Grace H. & John L. Sperry.

Paratypes 14 males, 11 females same data, July 16 to Aug. 29, 1946, 47 and in the collections of the Los Angeles County Museum, U. S. National Museum, Canadian National Museum, Mu-

seum of Comparative Zoology, American Museum of Natural History, British Museum, French National Museum and the Sperry collection.

It gives me great pleasure to name this interesting species in honor of our friend Mrs. Lloyd M. Martin. I truly believe that there must be a special place in heaven, reserved for the wives of entomologists as a part payment for vacation trials and tribulations suffered while helping a rabid husband to bring from the wilderness a grain or two of new information to add to the world's store. So it gives me a special pleasure to name a species of her own collecting for such an one of our friends. May there be many more good trips, Dorothy, to fill in the blank spots in our knowledge of the fauna of the Southwest.

Through the kindness of Mr. Lloyd M. Martin of the Los Angeles County Museum and one of our best known Southern California lepidopterists, Mr. M. L. Walton, the author has been privileged to examine a short series of one of the most beautiful geometrids which has been seen in some time. These four specimens taken by Mr. Walton in the Chiracahua Mts. of Southern Arizona represent a species unknown to the author and in due course will probably require a new genus to receive them. For the time being the author ventures to describe this species under the old genus *Azelina* Gn. which should be broad enough to receive almost anything in this group.

AZELINA WALTONARIA sp. n.

Male antennæ bipectinate, apex simple, female antennæ dentate. Palpi short, scarcely reaching beyond the front, upturned, heavily scaled, third joint short, close scaled. Thorax clothed with long silky hair, parting this shows it loose scaled beneath. Abdomen close scaled with short lateral tufts. Front smooth scaled, tongue developed, fore tibia unarmed, all spurs present, hind tibia of male swollen with strong hair pencil.

Head, front and vertex ochreous-buff, antennæ black-brown, thorax bister, abdomen light mineral-gray. Fore wing, basal area chestnut brown dusted with violet gray scales along costa and inner margin and mixed with white scales along inner margin and below cell. T.a., a thin black line, starts ¼ out on costa, goes diagonally out toward tornus with outward tooth in cell, curves sharply inward from vein 2 and outward to vein 1 thence inward to inner margin at 4/10 from the base, edged inwardly, irregularly with gray and white scales. The median area is liver brown. T.p. line very thin, black, starts 1/5 out from apex on costa at right angles, curves in from vein 8 and out to just above vein 6 making a small double pointed, outward tooth at the vein, curves sharply back and down to vein 4, thence in scallops, bulging out between

the veins, to inner margin at one third from anal angle, the deepest scallop is between veins 3 and 4. The beginning of a subterminal scalloped black line 2 mm. out from apex on costa, fades out at vein 6. Subterminal area is white except the apical area beyond the s.t. line which is light red brown, and a broad spot between veins 2 and 4 distad of the t.p. line and a diffused shading of lines 2, 3 and 4 subterminally, which are rose brown. The white area is stained with yellowish scales and the whole outer area irrorated with black, in irregular lines subparellel to outer margin, these irrorations lighter toward the tornus. Discal spot annulate, violet gray center and irregular surrounding black ring. Fringe white with wide, dark checks at ends of veins.

Secondaries, basal half of wing covered with long hairs. Bright apricot orange, fading out above the cell to gray white, with a dark area of purple gray scales below the cell to the junction with vein 2 thence to t.p. line.

T.a. line absent, t.p. line starts at inner margin 3 mm. from anal angle narrow, bright brown and well marked to vein 2, thence fading to red orange and almost lost in the ground color, scalloped between the veins. The t.p. on the under side of the secondaries, which is much heavier than that on the upper side and curves nearer the outer margin above vein 2, shows through.

The tornal area between the t.p. line, vein 2 and the margins is white irrorated with brown. Fringes yellowish white, slightly darker at ends of veins. Discal spot beneath shows dimly through. There is no terminal line on either wing.

Beneath, ground color pale grayish-blue-violet on both wings, laved with yellow brown over upper half of fore wing to t.p. line and between veins 2 and 4 and at apex on primaries. T.p. line of primaries as on upper side but dim, as is the black discal spot which is not annulate. Secondaries sprinkled lightly with yellowish brown between base and t.p. line except for an unshaded band along inner margin. T.p. line narrow bright brown, curved irregularly from 1½ mm. above inner margin 3 mm. from anal angle goes subparallel to outer margin to costa, with an inward scallop between veins 4 and 6; veins outlined in straw-yellow. Fringes as above. Discal spot black, distinct. Expanse, male 37 mm. female 40 mm.

The maculation of the female is the same, but the discal spot on the under side of the secondaries is duller.

Holotype, male, Chiricahua Mts., Arizona, near Ranger Station, Oct. 11, 1948 (M. L. Walton, coll.) and in the collection of Grace H. & John L. Sperry.

Allotype, female, same data, in the Walton collection.

Paratypes, 2 females, same data, and in the collection of the Los Angeles County Museum and collection Walton.

There is no species in the North American fauna with which the author is acquainted which remotely resembles *waltonaria*, perhaps the closest of which I have knowledge is *Gonodontis paliscia*, Prout from South Africa. The author is not satisfied that the genus is correct, but the pectinate antennæ of the male, the dentate antennæ of the female, the swollen male hind tibia with hair pencil and the silky hair which makes up the vestiture of the thorax in both sexes seem to definitely prevent its inclusion in *Pero, Stenaspilates* or *Gonodontis*. The wing venation insofar as can be seen without denuding the wings would fit in any of the aforementioned genera. For the time being, the author will place it, in the Sperry collection, immediately before the genus *Stenaspilates*, Pack.

It seems fitting that such a beautiful species shold be named in honor of a lepidopterist who, over so many years, has collected such a large number of interesting species in out-of-the-way corners of the Southwest and in so doing has greatly enhanced our knowledge of the lepidoptera of this area. It gives me great pleasure to name this fine species in honor of our colleague, Mr. M. L. Walton of Glendale, California.

TWO NEW SPECIES OF MYTILOPSIS FROM PANAMA AND FIJI

By LEO GEORGE HERTLEIN and G. DALLAS HANNA
California Academy of Sciences

Recently we identified a series of marine mollusks collected by Dr. James Zetek, of the Institute for Research in Tropical America, at Barro Colorado Island Biological Laboratory in the Panama Canal Zone. In this series we observed about 25 specimens of *Mytilopsis* found at Miraflores Locks, Canal Zone, Panama. The shells in this lot are remarkably constant in general features. They differ from any described species in outline as well as in other details, therefore we describe this Panamanian form as a new species.

Along with the type lot there is a small piece of wood in which there are rounded holes approximately 10 mm. in diameter. In the holes there are well-formed, uneroded shells of *Mytilopsis*. It appears then, that the species nestles in holes already made such as mentioned regarding *M. sallei* by von Martens (Biol. Centrali-Americana, Moll., 1900, p. 478).

Another species, apparently undescribed, also has come to our attention. This species is represented by four specimens all with both valves intact. These were present in a collection of shells from "Viti Isles" presented by the Misses E. and L. Allyne to the California Academy of Sciences in 1929.

FAMILY DREISSENSIIDÆ

Several authors have discussed the members of this family. Among these are Fischer[1], Andrussow,[2] Crosse & Fischer[3] and Brusina[4]. Crosse & Fischer gave a review of the literature dealing with the family, referred to previously described American species and clearly explained the many changes in orthography which the genus name *Dreissensia* has undergone. The genus, according to Dewalque, and Crosse & Fischer, was named for Henri Dreissens who lived in Limbourg, Belgium.

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[1]Fischer, P., Journ. de Conchyl., Vol. 7, 1858, pp. 123-134.

[2]Andrussow, N., Verhandl. Russ.-Kais. Min. Gesell. (St. Petersburg), Ser. 2, Bd. 26, 1890, pp. 223-240; Les Dreissensidæ fossiles et vivants d'Eurasie (St. Petersbourg), 1897, 683 pp., 15 figs. in text, atlas with 20 plates, also resumé of this paper in the German language, (Jurjev) 1898 [according to Brusina, 1906].

[3]Crosse, H., and Fischer, P., Miss. Sci. au Mexique et Amér. Centrale, Zool. Pt. 7, Moll., Vol. 2, 1890, pp. 497-505.

[4]Brusina, S., Journ. de Conchyl., Vol. 53, No. 3, 1906, pp. 272-297.

Genus Mytilopsis Conrad

Mytilopsis Conrad, Proc. Acad. Nat. Sci. Philadelphia, Vol. 9, for June, 1857, p. 167 [apparently issued between January 7 and May 1, 1858]. Species cited: *Mytilus leucophæatus* Conrad and *Dreissena domingensis* Recluz.—Dall, Trans. Wagner Free Inst. Sci., Vol. 3, Pt. 4, 1898, p. 808. "Type *M. leucophæatus* Conr., 1831" [Jour. Acad. Nat. Sci. Philadelphia, Vol. 6, April, 1831, p. 263, pl. 11, fig. 13. "Inhabits the southern coast of the U. S."].

Praxis H. & A. Adams, Gen. Rec. Shells, Vol. 2, December, 1857, p. 522. Not *Praxis* Guenée, 1852. Lepid.

Mytiloides Conrad, Proc. Acad. Nat. Sci. Philadelphia, Vol. 26, May 19, 1874, p. 29. Err. for *Mytilopsis* according to Conrad, p. 83. Not *Mytiloides* Brongniart, 1822.

Shell mytiliform, attached by a byssus; hinge with a septum, beneath which on the cardinal side is a triangular cup-shaped process; cartilage groove rather deep. (Original description).

The genera *Mytilopsis* and *Congeria* differ from *Dreissensia* in that a triangular process (myophore) is present on the under side of the septum within the beaks.

The genus *Mytilopsis* is represented by a number of species in the tropical American region. It occurs in waters which are slightly brackish or entirely fresh. It is known to occur at least as early as the lower Miocene or upper Oligocene.

This genus also occurs in Africa and a new species, *Mytilopsis allyneana,* described in the present paper, came from Fiji. The occurrence of this species is in harmony with the past history of Fiji which, according to Ladd,[5] appears to have once formed a portion of a continental area. Dall[6] mentioned the occurrence of "*Congeria*" in the Viti Isles. However, *Mytilus leucophæatus* Conrad and other species now referred to *Mytilopsis* were placed by Dall in *Congeria* Partsch. The type of *Congeria*[7] is *Congeria subglobosa* Partsch.

Mytilopsis allyneana Hertlein & Hanna, new species

Plate 4, Figures 5-8

Shell small, mytiliform, gently sloping dorsally, rather steeply sloping ventrally; dorsal outline forming a very broad curve, widest anterior to the center where it becomes subangulate and then slopes posteriorly in nearly a straight line rounding into the broadly elliptical posterior end; ventral margin slightly curved and slightly but decidedly incurved below the beaks where a well

[5]See Ladd, H. S., Bernice P. Bishop Mus., Bull. 119, 1934, p. 51, fig. 6 (p. 50).
[6]Dall, W. H., Trans. Wagner Free Inst. Sci., Vol. 3, Pt. 4, April, 1898, p. 809.
[7]See Pilsbry, H. A., Nautilus, Vol. 25, No. 8, December, 1911, p. 95.

developed byssal gape is present; umbos rounded, slightly eroded, smooth, beaks terminal; interior septum and muscular impressions are characteristic of the genus; fine radial striæ are present on the central and posterior portions of the interior of the shell; exterior of shell whitish, covered with a thin, corneous periostracum which is finely concentrically ridged in harmony with the lines of growth; interior bluish-white with dark concentric markings. Dimensions of holotype: beak to base, 23.5 mm.; dorso-ventral, 12.6 mm.; convexity (both valves together), 10.6 mm.

Holotype, No. 9452 and Paratype, No. 9453 (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from "Viti Isles" [Fiji].

This new species bears a general resemblance to *Mytilopsis africanus* van Beneden from Africa. It differs from that African species in that it is wider in proportion to the length and the beaks are less attenuated. The less attenuated beaks and greater incurving below the beaks are features which assist in separating this new species from the shell described by Reeve as *Mytilus tenebrosus*.

MYTILOPSIS ZETEKI Hertlein & Hanna, new species

Plate 4, Figures 1-4

Shell small, mytiliform, flattened dorsally, sloping rather steeply ventrally; dorsal outline forming a broad curve, widest slightly anterior to the center, continuing around the posterior end which is obliquely elliptically pointed; ventral margin very slightly curved except where it is distinctly incurved just below the beaks; umbos rounded, smooth, beaks terminal; interior with a narrow septum which ventrally bears a sharp triangular process (myophore) which extends down and somewhat posteriorly; internal muscular impressions characteristic of the genus; fine radial striæ are present on the interior of the central and posterior portions of some shells; shell white, covered with a thin, corneous periostracum which is finely concentrically ridged in harmony with the lines of growth; a dark byssus is present; interior white often with bluish concentric markings. Dimensions of holotype: beak to base, 25 mm.; dorso-ventral, 13 mm.; convexity (both valves together), 14 mm.

Holotype, No. 9445 and Paratypes, Nos. 9446-9451 (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Miraflores Locks, Panama Canal Zone; James Zetek, collector, 1937.

The shells of some of the species described in this group appear to differ from each other chiefly in their outlines. The species here described as new resembles in general features *Mytilopsis adamsi* Morrison, described from San José Island in Panama Bay. It differs from that species in that the posterior dorsal outline is

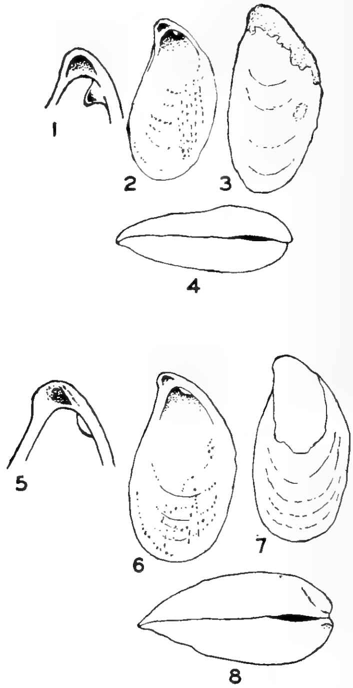

PLATE 4

FIGS. 1-4. *Mytilopsis zeteki* Hertlein & Hanna, new species. 1-2. Paratype. No. 9446 (Calif. Acad. Sci. Dept. Paleo. Type Coll.). Beak to base, 23.5 mm. 3. Paratype, No. 9447 (Calif. Acad. Sci. Dept. Paleo. Type Coll.). Beak to base, 26.5 mm. 4. Holotype, No. 9445 (Calif. Acad. Sci. Dept. Paleo. Type Coll.). Beak to base, 25 mm.

FIGS. 5-8. *Mytilopsis allyneana* Hertlein & Hanna, new species. 5-7. Holotype, No. 9452 (Calif. Acad. Sci. Dept. Paleo. Type Coll.). Beak to base, 23.5 mm. 8. Paratype, No. 9453 (Calif. Acad. Sci. Dept. Paleo. Type Coll.). Beak to base, 24.9 mm.

straighter and the posterior end of the shell is more obliquely elliptical.

This species is named for Dr. James Zetek who collected the type specimens.

References to a number of Cenozoic species of *Mytilopsis* have been consulted by us during our study of the present species. We have brought these together here for the convenience of other workers. The arrangement is alphabetic by species under the genus as originally described.

Mytilopsis adamsi Morrison, Smithson. Miscell. Coll., Vol. 106, No. 6, (Publ. 3850), September 12, 1946, p. 46, pl. 1, figs, 4, 7. "collected in the upper end of the lagoon at the mouth of Musselshell Creek, which is the largest of the streams in the southeastern part of San José Island. They were principally found attached by the byssus to the underside of rocks in the uppermost end of this (fresh-water) lagoon in the lowermost part of the stream proper, in situations where there was plenty of stream current remaining."

Dreissena africana Van Beneden, Bull. Acad. Roy. Sci. Bruxelles, Vol. 2, 1835, p. 167. "' . . . habite le haut du Sénégal' ". With fluviatile mollusks.—Reeve, Conch. Icon., Vol. 10, *Mytilus,* 1858, sp. 47, pl. 10, fig. 47 (as *Mytilus africanus*). "Hab. Senegal."

Mytilopsis cira Pilsbry & Olsson, Rev. Acad. Colombiana de Cienc. Exact., Fis. y Nat., Vol. 4, Nos. 15-16, August-December, 1941, p. 416. "Formacíón de la Cira: Rio Oponcito, inmediaciones de Guanábanas, Colombia." Upper Oligocene or lower Miocene.

Dreissena cyanea Van Beneden, Bull. Acad. Roy. Sci. Bruxelles, Vol. 4, 1837, p. 41, pl. [unnumbered], figs. 1, 2, 3. "Nous ne connaissons rien de certain sur la localité de cette espèce, M. d'Orbigny, qui a eu l'obligeance de me la communiquer, l'a reçue d'un de ses amis, qui la croit du Sénégal."

Dreissensia dalli Joukowsky, Mem. Soc. Phys. et Hist. Nat. Genève, Vol. 35, Fasc. 2, October, 1906, p. 171, pl. 6, figs. 1-5. "Localité: Ruisseau de Bombacho, au S. de Macaracas, 1^{m}. audessous de la couche de lignite." Panama. Tertiary. [Probably Miocene or Pliocene according to Woodring].

Praxis ecuadoriana Clessin, Malakozool. Blätter, N. F., Bd. 1. 1879, p. 180, pl. 15, fig. 8 (a, b). "Hab. in superiori parte fluminis Cayapas in prov. Esmeraldas, Wolf legit." P. 181 "Die Muschel wird von den Indianern gegessen, und findet sich stellenweise massenhaft an Felsen und alten, im Wasser liegenden Baumstämmen. (Wolf)."

Praxis milleri Clessen, Malakozool. Blätter, N. F., Bd. 1, 1879, p. 179, pl. 15, fig. 7 (a, b). "Habitat. Rio Verde in prov. Esmeraldas; Wolf legit." On p. 180 "Die Muschel sitzt in grosser Menge an von Wasser uberflutheten Felsen, Buamenstämmen, etc."

Dreissensia ornata Morelet,, Journ. de Conchyl., Vol. 33, (Ser. 3, Vol. 25), No. 1, 1885, p. 32, pl. 2, figs. 10, 10a. "Le *D. ornata* vit dans la rivière Mayumba." Equatorial Africa.

Dreissena sallei Recluz, Journ. de Conchyl., Vol. 3, December, 1852, p. 255, pl. 10, fig. 9. "Habite le Rio dulce (république de Guatimala), dans les pierres qu'elle perfore et où on la trouve agglomérée."—Crosse & Fischer, Miss. Sci. Mexique et Amer.

Centrale, Zool., Pt. 7, Moll., Vol. 2, 1890, p. 504, pl. 62, figs. 4, 4a, 5, 6. [Referred to subgenus *Mytilopsis*].

Dresseina scripta Conrad, Proc. Acad. Nat. Sci. Philadelphia, Vol. 26, May 19, 1874, p. 29, pl. 1, figs. 12, 16. "Pebas Group." "On the upper Amazon." Peru.—Pilsbry, Proc. Acad. Nat. Sci. Philadelphia, Vol. 96, 1944, p. 152 (as *Mytilopsis scripta*). Pebas Group, Peru. Probably Pliocene.

Mytilopsis singewaldi Pilsbry, Proc. Acad. Nat. Sci. Philadelphia, Vol. 96, August 11, 1944, p. 147, pl. 11, figs. 35, 36. Station 154." "About one-half mile upstream from San Antonio, Pachitea River." [As cited for Station 154 under *Corbicula* sp., p. 146. This differs in wording from that cited for Station 154 under *Hemisinus* (*Longiverena*) *avus*. p. 145]. Peru Upper Oligocene or lower Miocene.

Mytilus tenebrosus Reeve, Conch. Icon., Vol. 10, *Mytilus*, January, 1858, sp. 46, pl. 10, fig. 46. "Hab. Mississippi." [*Dreissena cumingiana* Recluz, Ms., cited in synonymy].

Septifer trautwineana Tryon, Amer. Jour. Conch., Vol. 2, Pt. 4, October 1, 1866, p. 302, pl. 20, fig. 8. "Habitat.—River San Juan, New Granada." . . . "in the Rio San Juan, a small stream, emptying into the Pacific in latitude 4°."

Crosse & Fischer mentioned that all the American species which they had examined were referable to *Mytilopsis*. They considered it to be a subgenus of *Dreissensia*. They stated that *Mytilopsis* is represented by a large number of species now living in the Americas and in Africa and by a number of species in the Tertiary of eastern Europe.

In addition to the species which we have cited above there are several others, chiefly in the Caribbean region, cited by Crosse & Fischer under *Dreissensia*. These included: *Dreissensia americana* Recluz, Florida; *D. cumingiana* Dunker, Mississippi; *D. domingensis* Recluz, Santo Domingo; *D. gundlachi* Dunker, Cuba; *D. leucophæata* Conrad, Virginia; *D. mörchiana* Dunker, Island of St. Thomas; *D. pfeifferi* Dunker, Cuba; *D. riisei* Dunker, Island of St. Thomas; *D. rossmässleri* Dunker, (?) Brazil.

A CHECK LIST OF THE LIMACIDÆ, ENDODONTIDÆ, ARIONIDÆ, SUCCINEIDÆ, PUPILLIDÆ, VALLONIIDÆ, CARYCHIIDÆ, AND TRUNCATELLIDÆ OF CALIFORNIA

(From Henry A. Pilsbry's Monograph)

By WILLIAM MARCUS INGRAM
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This is the third and last paper of a series forming a check list of the Helicoid snails of California based on Henry A. Pilsbry's monograph, "The Land Mollusca of North America (North of Mexico)," (1939) (1940) (1946) (1948). The mollusks listed here are considered in volume 2, part 2 (1948), the final part, of Pilsbry's monograph. In addition to the listing of the mollusks of Pilsbry's (1948) final part of his monograph a list of corrections and additions covering all parts of his monograph are included, with a list of Berry's (1940) species of *Monadenia,* referred to by Pilsbry (1948).

To those who have the two prior papers of the writer's check list (1946) (1948), and this one there is available, then, a general list that can be taken into the field to present data on mollusks of a proposed collecting area. Too, a skeletal list is available that can be used to keep the number of California land snails up to date as new species are added to our fauna. Locality data likewise can be added to this check list as further collecting in the state adds new localities for land snail species.

The families of land mollusks included herein contain the following number of species and subspecies: Limacidæ, eight species; Endodontidæ, eight species and subspecies; Arionidæ, fourteen species and subspecies; Succineidæ, five species; Pupillidæ, twenty species and subspecies; Valloniidæ, five species; Carychiidæ, one species; Truncatellidæ, two species; and Helminthoglyptidæ, nine species and subspecies.

SPECIES LIST

FAMILY—LIMACIDÆ

Limax maximus Linnæus

Los Angeles County; Hollenbeck Park, Los Angeles.
San Bernardino County: One mile southwest of Lake Arrowhead, San Bernardino Mountains.

San Diego County: San Diego.
San Francisco County: Golden Gate Park, San Francisco.
No specific localities in Calaveras and Santa Clara counties.

Limax flavus Linnæus

Alameda County: Berkeley.
Butte County: Chico.
Los Angeles County: Los Angeles.
San Bernardino County: Redlands.
San Mateo County: Halfmoon Bay.
Ventura County: Ojai.
No specific localities in Orange, San Luis Obispo, and Santa Barbara counties.

Limax marginatus Müller

Los Angeles County: Santa Catalina Island.
Orange County: Carbon Canyon, 2 or 3 miles east of Olinda.
No specific locations in Alameda, Butte, Kern, Kings, Lake, Madera, Modoc, Riverside, San Bernardino, Santa Barbara, San Diego, San Mateo, Sutter, Tehama, Tulare, and Ventura counties.

Deroceras reticulatum (Müller)

No specific localities in Alameda, Butte, Calaveras, Humboldt, Los Angeles, San Bernardino, San Francisco, San Mateo, Santa Clara, Tulare, and Ventura counties.

Deroceras læve (Müller)

Nevada County: Truckee (=*Limax campestris* var. *occidentalis* of Cooper)
San Diego: Julian (= *Limax hemphilli* of W. G. Binney)
San Francisco County: San Francisco (= *Limax campestris* var. *occidentalis* of Cooper)
Santa Cruz: Santa Cruz (= *Limax campestris* var. *occidentalis* of Cooper)

Deroceras monentolophus (Pilsbry)

Type: 180659 Academy of Natural Sciences, Philadelphia.

Type locality: Carbon Canyon, Orange County.
Orange County: Carbon Canyon.
Mendocino County: One mile west of Hale's Grove on the Rockport (U. S. Highway 101) road.
Los Angeles County: Northeast end of Brea Canyon near its junction with Puente Road; Cedar Creek, North fork of San Gabriel Canyon, San Gabriel Mountains.
San Diego County: Near south end of Cuyamaca Lake.

Deroceras caruanæ (Pollonera)

Alameda County: Oakland; Berkeley.
San Francisco: Golden Gate Park, San Francisco.
No specific localities in Contra Costa and Monterey Counties.

Milax gagates (Draparnaud)

Los Angeles County: Middle Ranch Canyon and Cherry Cove, Catalina Island.
San Diego County: Julian City.
San Francisco County: San Francisco.
Santa Barbara County: West Anacapa Island.
No specific localities in Alameda, Kern, Lake, Los Angeles, Napa, Orange, Sacramento, San Bernardino, San Luis Obispo, San Mateo, Santa Clara, Santa Cruz, Stanislaus, Tehama, and Ventura Counties.

FAMILY—ENDODONTIDÆ

Discus cronkhitei (Newcomb)

Type: Type and paratypes numbered 26391 in the Newcomb Collection, Cornell University.
Type locality: Klamath Valley, Oregon.
Butte County: Feather River Canyon.
Fresno County: Fish Camp, and Tehipite Valley.
Lassen County: Duck Lake, 20 miles west of Susanville, and Eagle Lake.
Madera County: Flats Big Tree Creek.
Mariposa County: Yosemite National Park.
Modoc County: Goose Lake.
Siskiyou County: Bartles on McCloud River; Sacramento River.
Tulare County: Wawona Meadow Sequoia National Park; Panther Creek, Giant Forest; Woods Creek; Bubb's Creek Falls; Summit Meadow; Funston Meadow, Kern Butte and Big Arroyo Kern River; Little Kern Lake.
No specific localities except San Bernardino Mountains, San Bernardino (?) County.

Discus shimeki (Pilsbry)

Type: 12297 Academy of Natural Sciences, Philadelphia.
Type locality: Yarmouth and Peorian loesses: near Iowa City, Iowa.
Inyo County: Wacobah Spring, Inyo Mountains.
Tulare County: Tyndall Creek.

Discus (?) *selenitoides* (Pilsbry)

Type: 60010 Academy of Natural Sciences, Philadelphia.

Type locality: Mariposa Big Trees in Yosemite National Park near Wawona, Mariposa County.

Mariposa County: Mariposa Big Trees in Yosemite National Park near Wawona; same general vicinity but just outside of park boundaries at the junction of Alder Creek and the South Fork of the Merced River.

Heliodiscus salmonaceus W. G. Binney

Type: 12752 Museum of Comparative Zoology, Harvard University.

Type locality: "On the Salmon River," Idaho.

Alameda County: Oakland (this record is subject to doubt).

Punctum californicum Pilsbry

Type: 62290 Academy of Natural Sciences, Philadelphia.

Type locality: Fish Camp, Fresno County, California.

Alameda County: Hills east of Haywards.

Calaveras County: Around Murphy's; Mercers Cave; Calaveras Big Trees.

Inyo County: Onion Valley; Kearsarge Pass.

Los Angeles County: San Rafael Hills, canyon end of El Arbolito and North Fork South San Gabriel Canyon.

Mariposa County: Mariposa Big Trees.

San Bernardino County: Near Bluff Lake, San Bernardino Mountains.

San Diego County: San Diego.

San Francisco County: San Francisco.

Siskiyou County: Headwaters of Sacramento River.

Tulare County: Big Trees; Forks of the Tule River; Little Kern Lake.

Punctum conspectum (Bland)

Mariposa County: Between Camp Curry and Vernal Falls Yosemite Park.

No specific localities in Alameda, Calaveras, Los Angeles, Mariposa, Marin, Monterey, Napa, San Bernardino, San Diego, San Francisco, Santa Clara, and Siskiyou counties.

Punctum conspectum pasadenæ Pilsbry

Los Angeles County: Pasadena; North end of Griffith Park.

Oregon County: San Juan Capistrano Creek.

"Zonites" diegoensis (Hemphill)

San Diego County: Near Julian City, on Cuyamaca Mountain 4,500 foot elevation.

FAMILY—ARIONIDÆ

Arion hortensis Ferussac

Alameda County: Oakland; Niles.
San Francisco County: San Francisco.

Arion circumscriptus Johnston

San Francisco County: Golden Gate Park, San Francisco.
Pilsbry's (1948) note: Widely spread in the San Francisco Bay Region.

Arion intermedius (Normand)

Alameda County: Berkeley.
Riverside County: Idyllwild.
Ventura County: Santa Paula Canyon.
Pilsbry's (1948) note: Common in San Francisco Bay Region (p. 676).

Prophysaon andersoni (J. G. Cooper)

Type: A Neotype 69010 Academy of Natural Sciences, Philadelphia.
Type locality: Oakland selected.
Alameda County: Oakland.
Pilsbry's (1948) note: Counties west of Coast Range, Santa Cruz to Humboldt (at Crescent City); near South and east sides of San Francisco Bay to Santa Cruz (p. 684).

Prophysaon fasciatum Cockerell

Mendocino County: No specific locality.

Anadenulus cockerelli (Hemphill)

Type: In California Academy of Sciences; paratypes 63895 Academy of Natural Sciences, Philadelphia.
Type locality: Julian, in the Cuyamaca Mountains, San Diego County.
Kern County: Near North Fork of Cottonwood Creek by ranch road 6 miles from junction with Breckenridge Mountain Road.
Los Angeles County: Upper Millard Canyon; San Gabriel Mountains; Calbaden Canyon, Puente Hills.
Orange County: Carbon Canyon, Puente Hills, Limestone Creek above Santiago Reservoir.
San Diego County: Julian in the Cuyamaca Mountains.

Ariolimax californicus Cooper

San Mateo County: Half Moon Bay; La Habra, Lake Andreas; Pescadero; San Francisquito Creek; Woodside.

Ariolimax californicus brachyphallus Mead

Type: Holotype and Paratype in collections of California Academy of Sciences, San Francisco.

Type locality: Mt. Davidson, San Francisco, San Francisco County, California.

San Francisco County: Mt. Davidson; Mt. Sutro, San Francisco.

Ariolimax dolichophallus Mead

Type: Holotype and Paratype in collections of California Academy of Sciences, San Francisco.

Type locality: Saratoga, Santa Clara County.

Santa Clara County: Saratoga, Congress Springs; Los Gatos.
Santa Cruz County: Big Basin; Big Trees; Boulder Creek; Chemeketa; Mt. Hermon, Brookdale; Hecker Pass; Santa Cruz.

Ariolimax columbianus (Gould)

Concerning the distribution of this species Pilsbry (1948, p. 719) states, " . . . in California south to Salinas Valley on the coast and at least as far south on the western slopes of the Sierra Nevada as Tuolumne County."

Ariolimax columbianus stramineus Hemphill

Type: Syntypes numbered 2317-2320 in California Academy of Sciences, San Francisco.

Type locality: Santa Cruz Island, Santa Barbara County.

Monterey County: Big Creek; Big Sur State Park; Hastings Reservation; Salinas Valley; Vincente Creek; 20 miles north of San Simeon.
San Luis Obispo County: Little Pico Creek.
Santa Barbara County: Cuyama Valley Road; El Montecito; Santa Cruz Island; Pelican Canyon and Rockslide Canyon; Santa Rosa Island in Water Canyon.
Ventura County: Santa Paula.

Hesperarion niger (J. G. Cooper)

Type locality: Pilsbry (1948) states, "Cooper's type was from the neighborhood of San Francisco Bay."

Alameda County: Mountains of Alameda County.
Kern County: No specific locality except northern Kern County.
Marin County: Bolinas.
Santa Clara County: Santa Clara; near San Jose.

Santa Cruz County: Santa Cruz range; 900 feet altitude.
Sonoma County: Santa Rosa; Healdsburg.
Pilsbry (1948), p. 724) concerning the distribution of this species, states " . . . covers the Coast and Bay counties from Sonoma to Santa Cruz. Tehama to Monterey counties.

Hesperarion hemphilli (W. G. Binney)

Type locality: Alameda County at Niles Station.
Alameda County: Niles Station; Haywards.
Los Angeles County: Elysian Park, Los Angeles; Arroyo Seco Canyon; upper Millard Canyon and Santa Anita Canyon, San Gabriel Mountains.
Orange County: Santa Ana Canyon; Black Star Canyon; Silverado Canyon; Trabuco Canyon, all in Santa Ana Mountains.

Binneya notabilis J. G. Cooper

Type locality: Santa Barbara Island.
Los Angeles County: Santa Barbara Island.

FAMILY—SUCCINEIDÆ

Oxyloma nuttalliana chasmodes Pilsbry

Type: Holotype numbered 5609 Academy of Natural Sciences, Philadelphia.
Type locality: Stockton, San Joaquin County.
San Joaquin County: Stockton.

Succinea rusticiana Gould

Type locality: Merely, "Oregon, U. S. Exploring Expedition."
Tulare County: Tulare Valley.

Succinea stretchiana Bland

Fresno County: Grouse Meadow; Tehipite Valley; Pavilion Dome; Palisade Creek; Fish Camp.
Inyo County: Wacobah Spring.
Kern County: Funston Meadow.
Lassen County: Duck Lake, 20 miles west of Susanville.
Madera County: Pumice Flats; Red Meadow; Jackass Dyke.
Mariposa County: Yosemite Valley; near Wawona, Sequoia Park.
Modoc County: Goose Lake.

San Bernardino County: Bluff Lake, San Bernardino Mountains.
Siskiyou County: Bartles, McCloud River.

Succinea gabbi Tryon

Type: Holotype and Paratypes 12487 Academy of Natural Sciences, Philadelphia.

Type locality: Crooked Creek of Owyhee 60 miles west of boundary Southeast Oregon.

Inyo County: Mazuka Canyon, Tank Spring.
Pilsbry (1948) in addition lists, "Crane Lake Valley N. E. Calif. (Gabb)."

Quickella rehderi Pilsbry

Type: Holotype and Paratypes 147757 Academy of Natural Sciences, Philadelphia.

Type locality: Davenport, Lincoln County, Washington.

In reference to the distribution of this species in California Pilsbry (1948, p. 847) states, "In the Pacific states there is, however, a long series of succineas which resemble *rehderi* more or less, or are of stouter figure, and have generally gone under the name of "*S. oregonensis*." Shells of that kind occur from Montana and Washington to southern California." No specific localities are cited in Pilsbry's (1948) distribution section for this species.

FAMILY—PUPILLIDÆ

Gastrocopta pellucida hordeacella (Pilsbry)

Type: Types and Paratypes 60460 Academy of Natural Sciences, Philadelphia.

Type locality: New Braunfels, Texas.

Riverside County: Palm Canyon in San Gabriel Mts., Mojave Mt.

Vertigo ovata mariposa Pilsbry

Type: 11644 Academy of Natural Sciences, Philadelphia.

Type locality: Meadow near Wawona, Sequoia Park, Mariposa County.

Mariposa County: Meadow near Wawona, Sequoia Park.

Vertigo berryi Pilsbry

Type: 105166 Academy of Natural Sciences, Philadelphia.

Type locality: Mill Creek Canyon at 4600 feet in the San Bernardino Mountains.

Vertigo andrusiana sanbernardinensis Pilsbry

Type: 118419 Academy of Natural Sciences, Philadelphia.

Type locality: San Bernardino Mountains, 7550 to 7750 feet in the cienaga below Bluff Lake.

San Bernardino County: 7550 to 7750 feet in the cienaga below Bluff Lake; Bluff Lake meadow; area north of lake.

Vertigo sterkii Pilsbry

Type: Pilsbry (1940) states that the type and type locality is somewhere near or west of the western end of Lake Superior.

Under this species Pilsbry (1940) states, "The typical *modesto* is replaced in the Rocky Mountain system and California by various weakly differentiated races." Under *V. modesta corpulenta* (Morse) Pilsbry (1940) assigns a definite locality to *V. modesta* as from "Simpson's Meadow King's River."

Vertigo modesta corpulenta (Morse)

Type locality: Little Valley, Washoe County, Nevada, on the east slope of the Sierra Nevada, 6,500 feet above the sea.

Pilsbry (1940) under this subspecies refers to two "forms," *V. modesta parietalis* (Ancey) and *V. modesta microphasma* Berry. The latter form has a type locality, near Bluff Lake in the San Bernardino Mountains at 7200 to 7550 feet; a type is housed as no. 2740 in the S. S. Berry collection, Redlands, California and a paratype as 44788 in The Academy of Natural Sciences, Philadelphia. Pilsbry's (1948) reference to the former "form's" occurrence in California is partially by general reference, "In the Sierra Nevada counties of California *V. modesta* and *parietalis* appear to be rather abundant"; and more specifically he lists, " . . . valleys of the San Joaquin and King's River, Bear and Fish Creeks, Fresno County." Other lots are listed as from Pumice Flats, Bear Creek, and Grouse Meadow (Fresno County ?). The type locality for *parietalis* is Ogden Canyon, Utah; the type is housed at the University of Michigan, Ann Arbor, Michigan.

Vertigo modesta castanea Pilsbry and Vanatta

Type: 11655 Academy of Natural Sciences, Philedelphia.
Type locality: Fish Camp, Fresno County.
Fresno County: Fish Camp.
Inyo County: Wawona Meadow; Onion Valley; Kearsarge Pass.
Lake County: No specific locality.
San Bernardino County: Holcomb meadows, east of Sugar Loaf Peak at 8300 feet in San Bernardino Mountains.
Tulare County: Ranger, Panther Creek, Wood's Creek, Funston Meadow on Kern River, Babb Creek Falls, Rae Lake.

Vertigo occidentalis Sterki

Type: 1860 in S. S. Berry collection, Redlands, California.
Type locality: San Bernardino Mountains at Bluff Lake, 7550 feet, San Bernardino County.
San Bernardino County: San Bernardino Mountains at Bluff Lake at 7500 feet; Bluff Lake cienega in the cienega just north and along the "New England Trail," 7500 feet; cienega west of Green Valley at 6900 feet.

Vertigo allyniana Berry

Type: 3764 in S. S. Berry collection, Redlands, California
Type locality: Donner Lake, Nevada County, California.
Nevada County: Donner Lake.

Vertigo dalliana Sterki

Type: 62.20383 Carnegie Museum, Pittsburg, Pennsylvania.
Type locality: Near Clear Lake, Lake County.
Lake County: Near Clear Lake.

Vertigo californica (Rowell)

Type: A paratype is numbered 59392 at Academy of Natural Sciences, Philadelphia.
Type locality: San Francisco, San Francisco County.
San Francisco County: San Francisco.

Vertigo californica trinotata (Sterki)

Type locality: Monterey, Monterey County.
Monterey County: Monterey.

Vertigo californica diegoensis (Sterki)

Type locality: False Bay near Asher Station, San Diego County.

San Diego County: False Bay near Asher Station.

Vertigo californica cyclops (Sterki)

Placer County: Rocklin (25 miles northeast of Sacramento).

Vertigo californica longa (Pilsbry)

Type locality: San Clemente Island, Los Angeles County.

Los Angeles County: San Clemente Island; Santa Barbara Island.

Vertigo californica catalinaria (Sterki)

Type locality: Santa Catalina Island, Los Angeles County.

Los Angeles County: Santa Catalina Island; San Clemente Island; Santa Barbara Island.

Vertigo californica cupressicola Sterki

Type: 118835 Academy of Natural Sciences, Philadelphia.

Type locality: Cypress Point, Monterey County.

Monterey County: Cypress Point.

Vertigo rowelli (Newcomb)

Type locality: Near Oakland.

Alameda County: Near Oakland.
El Dorado County: No specific locality.
Monterey County: No specific locality.
San Bernardino County: Cienega north of Bluff Lake, San Bernardino Mountains.

Sterkia hemphilli (Sterki)

Type: 62.20384 Carnegie Museum, Pittsburg, Pennsylvania.
Type locality: Bank of San Tomas River, Lower California.
San Bernardino County: Waterman Canyon.
San Diego County: Around San Diego; False Bay, Asher Station in drift; Mesa near Grantville under prickly pear stems; Pacific Beach.

Sterkia clementina (Sterki)

Type: 62.20392 Carnegie Museum, Pittsburg, Pennsylvania.
Type locality: San Clemente Island, Los Angeles County.
Los Angeles County: San Clemente Island; Santa Barbara Island.

FAMILY—VALLONIIDÆ

Vallonia pulchella (Müller)

Type locality: (Europe) Denmark.
Calaveras County: Murphey's.
Orange County: San Juan Capistrano Creek.
Santa Clara County: San Jose.
Shasta County: Redding.

Vallonia excentrica Sterki

Type: 10080 Academy of Natural Sciences, Philadelphia.
Type locality: Staten Island, New York.
Pilsbry (1948) does not list this species in his distributional list of states as being from California, but says in the text under this species, "It [*V. excentrica* Sterki] occurred among *pulchella* [*Vallonia pulchella*] from Los Angeles, Calif., collected by Dr. Stearns . . . "

Vallonia gracilicosta Reinhardt

Pilsbry (1948) does not include California in the locality list under this species, but he does list a "form," *Vallonia gracilicosta* form *montana* Sterki under the species in the s.s., and under the form he lists, "California: Mariposa Big Trees (H. B. Baker)."

Vallonia aibula Sterki

Type: 62.19236 Carnegie Museum, Pittsburg, Pennsylvania.
Type locality: St. Joseph, Quebec.
Tulare County: Funston Meadow.

Vallonia cyclophorella Sterki

Inyo County: Inyon Mountain.
Lassen County: Near Susansville..
Mariposa County: Mariposa Big Trees.
San Bernardino County: Mill Creek Canyon, San Bernardino Mountains.
Tulare County: No specific locality.

FAMILY—CARYCHIIDÆ

Carychium occidentale Pilsbry

Type: 22539 Academy of Natural Sciences, Philadelphia.
Type locality: Portland, Oregon.
Del Norte County: Ragged Canyon, 5 miles south of Crescent City.

FAMILY—TRUNCATELLIDÆ

Truncatella stimpsoni Stearns

Type: In United States National Museum, Washington. D. C.
Type locality: False Bay near San Diego.
Los Angeles County: Santa Catalina Island, The Isthmus.
San Diego County: False Bay near San Diego; La Jolla.

Truncatella californica Pfeiffer

Type locality: San Diego.
Los Angeles County: Santa Catalina Island, The Isthmus.
San Diego County: San Diego.

ADDITIONS AND CORRECTIONS

1.—In Ingram (1946, p. 62), *Theba pisana* (Müller) should be changed to *Helicella pisana* (Müller); see Pilsbry (1948, p. 1091).

2.—In Ingram (1946, p. 62, Family Helminthoglyptidæ) the following species and subspecies should be added; see Pilsbry (1948, pp. 1092-1093). Pilsbry's (1948) statement should be kept in mind, "The following species [of *Monadenia*] and subspecies were described by Berry in Journ. of Entom. and Zool., March, 1940. As the figures are in outline they do not show features of pattern and sculpture, which are among the chief differential characters."

Monadenia marmarotis Berry

Type: 8615 in S. S. Berry collection, Redlands, California.
Type locality: Altitude at about 5900 feet, one quarter to one half mile south of Marble Valley Ranger Station, Marble Valley, Siskiyou County, among marble and limestone rocks.

Siskiyou County: At about 5900 feet, one quarter to one half mile south of Marble Valley Ranger Station, Marble Valley; at about 6600 feet, Marble Mountain, above Marble Valley; Kelsey Creek Trail, one mile below Marble Valley Ranger Station; (?) Canyon Creek Trail, 6½ miles above Scott River.

Monadenia rotifer Berry

Type: 7794 in S. S. Berry collection, Redlands, California.

Type locality: Altitude at about 6000 feet on trail one half mile west of Whiskey Camp, Salmon Mountains, Siskiyou County.

Siskiyou County: Altitude at about 6000 feet on trail one half mile west of Whiskey Camp, Salmon Mountains.

Monadenia callipeplus Berry

Type: 7693 in S. S. Berry collection, Redlands, California.

Type locality: Altitude 2300 feet, Tompkins Creek, one mile above mouth.

Monadenia cristulata Berry

Type: 8614 in S. S. Berry collection, Redlands, California.

Type locality: Altitude at about 5800 feet above Pleasant Valley Lakes, Siskiyou County.

Siskiyou County: Altitude at about 5800 feet above Pleasant Valley Lakes.

Monadenia chaceana Berry

Type: 8678 in S. S. Berry collection, Redlands, California.

Type locality: Among rocks about halfway up a spur of Badger Mountain on west side of Shasta River Canyon not far above its mouth, Siskiyou County.

Siskiyou County: Among rocks about halfway up a spur of Badger Mountain on west side of Shasta River Canyon not far above its mouth. Pilsbry (1948) states, "Among woods," which should really read following Berry (1940), "Among rocks"; Lava rockslide ¼ mile below Copco Diversion Dam, Shasta River Canyon.

Monadenia fidelis scottiana Berry

Type: 8616 in S. S. Berry collection, Redlands, California.

Type locality: Kelsey Creek, 1 to 2 miles above mouth, Siskiyou County.

Siskiyou County: Kelsey Creek, 1 to 2 miles above mouth; middle fork of Kelsey Creek, on trail 5½ miles above Scott River; Canyon Creek, from near mouth to one mile above; Middle Creek ½ mile above mouth.

Monadenia fidelis callidina Berry

Type: 7087 in S. S. Berry collection, Redlands, California.

Type locality: "Dad's Camp," south side of Klamath River across from Requa, Del Norte County.

Del Norte County: "Dad's Camp," south side of Klamath River across from Requa; Chaffey Ranch, 7 miles above mouth of Klamath River; Terwah (Turwar ?).

Humboldt County: Perch Creek.

Siskiyou County: Butler Creek, ¼ mile above mouth.

Monadenia fidelis smithiana Berry

Type: 6960 in S. S. Berry collection, Redlands, California.

Type locality: North side of Smith River, 3 miles below Hiouchi Bridge, Del Norte County.

Del Norte County: North side of Smith River, 3 miles below Hiouchi Bridge; bank of Smith River near Hiouchi Bridge.

Monadenia infumata alamedensis Berry

Type: 5672, California Academy of Sciences, San Francisco, California.

Type locality: Haywards, Alameda County, California.

Alameda County: Haywards.

3.—In Ingram (1946, p. 67) under *Helminthoglypta californiensis* (Lea) add these additional localities, see Pilsbry (1948, p. 1093): "Found at several localities north of Monterey in the sand dunes, the farthest north being at points south of Point Lobos, the southernmost being just south of the mouth of the Little Sur River, about 15 miles south of Point Lobos. Our best collecting, both as to number of specimens and size of shells, was in the sand dunes about 3 miles north of Monterey . . . "

4.—In Ingram (1946, p. 73) under *Helminthoglypta sequoicola* (Cooper) delete south side of San Juan Grade, Monterey County, a locality which should be placed under *Helminthoglypta dupetithouarsi consors* Berry, see Pilsbry (1939, p. 140; 1948, p. 1093).

5.—In Ingram (1946, p. 83) for *Micrarionata tryoni carinata* Pilsbry read *Micrarionata tryoni hemphilli* (Hannibal), see Pilsbry (1948, p. 1093).

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TWO APPARENTLY NEW GEOMETRID SPECIES FROM THE SOUTHWEST

By JOHN L. SPERRY

Riverside, California

In the Sperry collection, there has been for some time a series of a Racheospila species, taken in the southern desert of California and going under the name of *diaphana,* Warren. In compiling the original descriptions of the Geometridæ the author noted that the type locality of *diaphana* is Peru and it seemed that there might be reason to doubt the occurrence of this species in the deserts of Southern California. Furthermore, Prout (Gen. Ins. 1912, 104) had placed *diaphana* in the first section in his division of the genus, which section is characterized by "Hindwing with C never anastomosing, abdomen very rarely with embossed spots, male antennæ with short or very moderate pectinations." Our Southern California species belonged without doubt in Section II having "C anastomosing shortly with the cell and abdomen with embossed white spots" although the male antennal pectinations are not long.

An appeal to the British Museum for information brought an immediate clarification of the problem. Mr. Fletcher informs me that *diaphana* Warr. equals *pomposa* Dogn. and falls to the older name. The types of *pomposa,* two males from Ecuador, are in the National Museum at Washington and so are unavailable to the author without a long journey which seems inadvisable.

The types of *diaphana* Warr., two females, are in the British Museum and Mr. Fletcher has kindly made slides of a female of our Southern Californian species and of one of type specimens and writes as follows: "I have had the opportunity of examining the types of Warren's *R. pomposa* (*diaphana*) from Peru. Your California specimen is certainly closely related to *pomposa* and so far as I can see is nearest to the Mexican race *p. indecora* Prout. In fact if your specimen had been larger I should probably have determined it as that without further check . . . I have made preparations of the tails and though they are very close they are undoubtedly distinct.

In *pomposa indecora* the sclerotised plate in the ductus bursæ is bluntly conical in shape, in the Californian specimen it is almost square and barely half the size."

With grateful thanks to Mr. D. S. Fletcher of the British Museum staff the author proposes to give the Southern Californian species a name and describes

Racheospila noël, sp. n.

Male and female: Palpi, moderate in male, long in female, white tinged with rose. Front, smooth scaled, white with wide dorsal rose band, white band between antennal shafts, collar narrowly rose. Antennal shafts white, pectinations, straw. Legs thin scaled with white, laved inwardly with pink atoms. Thorax and both wings, rivage green (Ridgway color). Abdomen beneath white, above green with large, raised, dorsal, white spots, circled broadly with rose on the first six segments, those on the third, fourth and fifth being larger than the others.

Primaries: Costa white bordered inwardly with rose, the latter heavy at the base and narrow or wanting beyond one-third out from the base. T.a. line narrow, white, leaves costa at 1/4 goes at right angles thereto to midcell, thence angling inward to lower edge of cell, thence outward and back to inner margin at one-third from base. T.p. line from beyond 3/4 on costa goes irregularly across wing to inner margin at two-thirds out from base, and angling sharply outward at the veins. A heavy, rose terminal line broken at the veins by white spots. Fringe white, with spreading rose spots at the vein ends. Discal spot distinct, rose, located at end of cell centrally.

Secondaries: T.a. and t.p. lines continued as on the primaries. T.a. line has shallow inward angle deviating from the curve and reaches inner margin at one-third. T.p. line reaches inner margin at four-fifths out from base. Fringes as in primaries. Discal spot rose, smaller than on primaries, at end of cell.

Beneath: much lighter green than above, forewing darker than hindwing.

Costa of primaries more heavily washed with rose than above. Discal spots on both wings minute. Lines show dimly through from upper side. Terminal line and fringes as above.

The expanse varies as does that of most desert geometrids, depending largely on the precipitation and temperature. There must be several broods, as the record shows winter, spring and summer captures in the type series before me. Expanse: Male 17-19 mm. Female 17-24 mm.

Holotype, male, Borrego, California, May 6, 1946, Grace H. and John L. Sperry coll. and in the Sperry collection.

Allotype, female, same data and in the same collection.

Paratypes, 5 males, 4 females, Borrego, Calif. and Tub Canyon, Borrego, Calif. Jan., Mar., May, July, Nov. and Dec. 1946, 7 and 8. Noël Crickmer coll. and in the U. S. National Museum, Canadian Nat. Museum, Museum of Comparative Zoölogy and British Museum; 2 males, Palm Springs, Calif., Mar. 4 and 8, 1922, Karl B. Coolidge coll. and 1 female same locality Oct. 11, 1922 and in the Los Angeles County Museum; 1 female, Borrego, Calif. Jan. 1946, Noël Crickmer, collector, and in the Crickmer collection; 2 males, Palm Springs, Calif. March and March 19, 1922, K. R. Coolidge, coll. and in the collection of the U. S. National Museum.

This species belongs next to *diaphana* Warr. in our check list and the author considers it doubtful if *diaphana* occurs in the United States. It differs from *pomposa* Dogn., as far as can be told from the description, by the lack of the yellow terminal and costal shading, by the presence of well marked t.a. lines and genitalically as stated by Mr. Fletcher.

As the best flight of this insect in the southern desert appears to begin about Christmas and as most of the Sperry series was taken by our friend Mr. Noël Crickmer at his Tub Canyon Guest Ranch in Borrego, California, it seems fitting to name this species in his honor, which the author ventures to do, with great pleasure.

Since 1937 there has been, in the Sperry collection, a single specimen of an unknown Chlorochlamys species from Mexican Wells, California; in 1947 and 1948, trips to the Organ Pipe Cactus National Monument in Southern Arizona turned up a small series which the author here describes as

Chlorochamys fletcheraria, sp. n.

Male and female: Palpi, rosy ochreous; front, light green; antennal shaft light buff, pectinations short, tawny. Vertex light buff between the antennal shafts. Legs light buff. Thorax, abdomen and both wings, vetiver green (Ridgway color) Costa of fore wing and maculation light buff, the costal light buff area narrower in the female.

Primaries: T.a. line starts at a triangular spot one-third out on costa and curves slightly outward in going to inner margin at one-third from base.

T.p. line irregular from triangular spot ¾ out on costa to inner margin ¾ out from base. The t.p. line has a tendency to bow inward slightly between the veins. The lines are narrow except at costa but are distinct on both wings. Fringes very light buff with a light-green shade line through the base. Discal dot absent.

Secondaries: T.a. line wanting. T.p. from slightly nearer the base than continuation of same line of the primaries, goes irregularly across wing to two-thirds out on inner margin, bowing out slightly between veins 2 and 5.

Discal dot wanting. Fringes as on primaries.

Beneath: Costa of primaries has a rosy ochreous tinge, lines of upper side show dimly through. The green scales darken terminally into an obscure terminal line. Color slightly lighter than above, especially along inner margin of both wings. Distal dots absent. Fringes as above.

Expanse, male 12-14 mm.; female 13-14 mm.

Holotype, male, Organ Pipe Cactus National Monument, Arizona, April 14, 1948, Grace H. and John L. Sperry. coll. and in the Sperry collection.

Allotype, female, Mexican Wells, California, July 7, 1937, Grace H. Sperry collector and in the Sperry collection.

Paratypes, 9 males, 3 females, Organ Pipe Cactus National Monument, Ariz., April 11-20, 1947, 48; 1 male, Alamo Canyon, Ajo Mts., Ariz. Apr. 22, 1948, G. H. and J. L. Sperry, Coll.; 1 male, Nogales, Ariz. Aug. 16, 1947, F. H. Parker; 1 male Madera Canyon, Santa Rita Mts., Ariz. and 1 female same locality, July 31, 1947, Comstock and Martin, and in the U. S. Museum, American Museum of Nat. History, British Museum, Museum of Comparative Zoölogy, Canadian National Museum, the collection of the Organ Pipe Cactus National Monument and collection Sperry; 43 males, 3 females, Madera Canyon, Santa Rita Mts., Arizona, July 23 to August 27, 1946 and 1947 Dr. John A. Comstock and Lloyd Martin, coll. and in the collection of the Los Angeles County Museum and collection Sperry.

This species belongs immediately after *zelleraria Pack.* in the list and is the smallest of the known Chlorochlamys species. It is a darker green than any other species known to the author. Unfortunately the author has found that the maculation of the wings is too variable in this genus to be a reliable character for separation at all times. The small size and the bright, well marked lines on the dark green ground, together with the green scaled front will separate this species from the others in most cases.

The genitalia are probably closest to *zelleraria* Pack. It has the needle-like ædeagus of the genus but has a small needle-like spine apically which is lacking in *zelleraria,* the uncus is shaped the same in both species but in *fletcheraria* is shorter and broader centrally; the valvæ are narrower than in *zelleraria* and the central raised ridge which is rough and almost toothed in *zelleraria* is almost smooth in *fletcheraria.* In the female the chitinized vag-

inal opening is much heavier in *zelleraria* and there is a plate above the opening which is lacking in *fletcheraria.*

It gives me great pleasure to name this beautiful insect in honor of Mr. D. S. Fletcher of the British Museum staff, whose careful examinations and friendly coöperation has encouraged the author to again describe in this difficult genus.

THE OCCURRENCE OF BINARY FISSION IN THE METACYCLIC FORM OF *TRYPANOSOMA CRUZI* CHAGAS FROM *TRIATOMA LONGIPES* BARBER

By SHERWIN F. WOOD
Los Angeles City College

Much discussion has centered about the presence or absence of division in the trypanosome form of the causative agent of Chagas' disease or American human trypanosomiasis. Brumpt[1] believed metacyclic forms, i. e., the infective rectal phase of the parasite in the insect, were incapable of division and Dias[2] supported this view after unsuccessful attempts at culturing metacyclic trypanosomes. However, Niño[3] recorded a form, Plate 1, Fig. 29, suggestive of binary fission on slides prepared from feces of *Triatoma infestans,* and demonstrated from culture a double trypanosome stage with one kinetoplast in figure 14 of Plate 4. Elkeles[4] published two excellent photomicrographs, 10 and 11, in Plate 6 of *Trypanosoma cruzi* in binary fission from the feces of *Triatoma infestans.* Whitaker[5] was successful in culturing *Trypanosoma cruzi* from *Triatoma protracta* feces and reported metacyclic division forms in these cultures. Meyer[6] observed binary fission in the trypanosome form in fowl tissue cultures of *Trypanosoma cruzi.*

The fragility of this parasite has been noted by Brumpt,[7] Wenyon[8] and other workers. The writer has been partially successful in overcoming this by the use of heat fixation, i.e., warmed glass slides. However, no exact temperatures have been worked out which guarantee consistently uniform results.

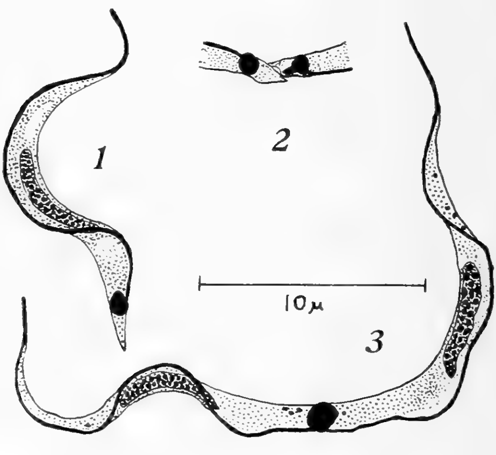
On June 10, 1947, the writer received a naturally-infected female *Triatoma longipes* Barber from Mr. W. J. Cummings who

[1]Brumpt, E., Précis de Parasitologie, p. 236, 1927.
[2]Dias, E., Mem. Inst. O. Cruz, vol 42, p. 502, 1945.
[3]Niño, F., Misi5n de Estudios de Patología Regional Argentina, 4th Reuniôn, pp. 600-604, 1928.
[4]Elkeles, G., Boletin de la Academia Nacional de Ciencias, vol. 36, p. 407, pl. 6, figs. 10 and 11, 1944.
[5]Whitaker, B. G., Doctorate Thesis, Univ. Calif. Library, Berkeley, 1937.
[6]Meyer, H., Biol. Abs., vol. 19, p. 812, 1944.
[7]Brumpt, E., ibid, p. 231, 1927.
[8]Wenyon, C. M., Protozoology, vol. 1, p. 490, 1927.

lives near Nogales, Arizona. Wishing to preserve types in the feces of this bug, the insect was fed on a guinea pig August 5th and isolated in a glass jar. The first voluntary fecal droplet was large and clear and was transferred with a capillary pipette to previously warmed glass slides and small droplets spread as for blood smears.[9] While searching for well-preserved metacyclic forms as illustrated in figure 1, the elongated specimen with single kinetoplast shown in figure 3 was found.

Subsequent study of ten smears prepared from this one fecal deposit revealed 36 specimens in various phases of division, only a few of which were well preserved. Twelve specimens showed the double form of figure 3 but with two kinetoplasts separated by protoplasmic bands of varying width. The division apparently begins with separation of the flagellum, undulating membrane and anterior organelles, followed by a splitting of the nucleus and parting of the two cytosomes which remain connected by a single kinetoplast as in figure 3. The division of the kinetoplast appears to be accompanied by a diagonal separation of the interconnecting broad, protoplasmic band, as in figure 2, resulting in a pointed posterior protoplasmic extension of the body capping each kinetoplast. The right kinetoplast in figure 2 was broken, as indicated by its irregular shape, but the remainder of each trypanosome showed typical nucleus, flagellum, undulating membrane and cytosome. In several specimens the interconnecting protoplasm was drawn out into a thin thread-like connection from broader protoplasmic caps covering each kinetoplast. Thus, binary fission apparently occurs in the metacyclic form of *Trypanosoma cruzi* harbored by *Triatoma longipes*.

[9] Wood, S. F., Am. Jour. Trop. Med., vol. 29, p. 44, 1949.



NEW FLEAS AND RECORDS FROM THE WESTERN STATES

By C. ANDRESEN HUBBARD
Vanport College, Portland, Oregon

There are before the writer at this time two new pocket gopher fleas from the State of Washington, several new collection records from Washington and Oregon; a new flea which is from Kern County, California and two new fleas found east of Death Valley, California, through southern Nevada and into northwestern Arizona and southwestern Utah.

WASHINGTON: The writer has before him at this time two new pocket gopher fleas from Washington State. Mr. Al W. Moore working in extreme southwestern Washington took a series of new fleas off pocket gophers which he sent to the writer. This new flea shall be called

DACTYLOPSYLLA MOOREI, a new species

Before the writer at this time are the holotype male and allotype female, a paratype male and two paratype females. The new species seems to fall midway between *D. comis* Jordan and *D. pacifica* Hubbard, but differs from them in the shape of the process and finger in the male and the apical outline of the VII sternite and its armature in the female.

Modified Segments: male. The process of the clasper is not finger shaped as in *comis* and *pacifica* but somewhat dome shaped and apically inclined towards the anterior. The finger of the clasper is evenly rounded apically while *comis* is hooked and *pacifica* is expanded. The anterior border is widened about half way down by a triangular process. The armature of the finger consists of a short spike at the apical anterior angle, two medium bristles slightly below posterior apical angle and midway down the posterior border a small bristle.

Female. Apical outline of the VII sternite undulate, the armature consisting of 30 or more bristles to the side, 10 of which are stout. The spermatheca is typical for the series and has the oval body, the crooked appendix and the apical appendage.
The new flea is large, as are all the giant pocket gopher fleas, both male and female measuring 4 mm. in length.

The type locally as established by Mr. Moore is 12 miles northeast of Cathlamet, Wahkiakum County, Washington where on May 27, 1949 he took the fleas off what he designates as a new subspecies of *Thomomys talpoides.*

Depositories: The types are deposited in the National Museum, the first pair of paratypes in the British Museum and the remaining female paratype in the Los Angeles County Museum.

The new flea bears the name of Mr. Al W. Moore of the Portland, Oregon office of the Fish and Wildlife Service.

Engaged in plague suppressive measures in central Washington Dr. C. W. Clanton of the Washington Department of Health removed two female fleas from Norwegian rats. These are doubtless true pocket gopher fleas. The writer finds them to be new. They shall be called

FOXELLA IGNOTA CLANTONI, a new subspecies

The 2 female fleas before the writer have a genal armature different from other *ignota* but seem to fall between *F.i. franciscana* Roths. from southern Oregon and California and *F. i. recula* J. and R. from the Pacific Northwest.

Head: Well rounded, the gena with two rows of bristles. The lower row consists of 2 long bristles, close together and next to antennal groove, then a short bristle midway between the margins and at the margin dropped out of line and below the longest bristle of the 4. The upper row is of 5 bristles, medium and evenly spaced. Postantennal region with one long, major bristle and a marginal row of a short, 2 very long and 5 medium bristles evenly spaced. Small bristles along antennal groove.

Modified Segments: The apical outline of the VII sternite of the female consists of a rounded lobe below, and above it the face is undulate. Armature consists of 6 major bristles and about as many minor bristles in an anterior row. The spearmatheca is typically ignota but small for the size of the flea. It consists of the globular body, the crooked appendix and the well defined appendage.

The 2 females under study measure about 3 mm. in length,

Dr. Clanton secured these fleas off *Rattus norvegicus* (Norwegian rat—probably chance host) 4 miles east of Odessa in Lincoln County, Washington on July 7, 1949. The holotype female is deposited in the National Museum, the paratype in the British Museum.

During his plague investigation in central Washington Clanton removed from the Sagebrush Vole (*Lagurus c. pauperrimus*) two new fleas described earlier this year by the writer as *Megabothris clantoni* and *Thrassis gladiolis johnsoni.* These were delivered to the Plague Suppressive Measures Laboratory of San Francisco

for plague reaction and to the writer for determination. Hundreds of them were available. Dr. Murray Johnson, physician and surgeon of Tacoma, Washington, working with Clanton for relaxation, secured specimens of the Idaho Pigmy Rabbit (*Brachylagus idahoensis*). The fleas were sent to the writer. The entire lot consisted of *Cediopsylla i. inæqualis* Baker. This flea is not new to Washington but the host record is the first for the State.

OREGON: The number of species and subspecies of fleas in Oregon has remained at 90 for a number of years. Recently, however, two new records have been added to the list. The writer has uncovered *Epitedia stanfordi* Traub in much of eastern Oregon. Mr. R. C. Erickson of the Malheur Wild Life Refuge sent to the writer specimens of fleas collected out of duck nests in the area. These were determined as *Ceratophyllus garei* Roths. a bird flea not yet recorded from Oregon. Specimens of the Idaho Pigmy Rabbit collected in Central Oregon by members of the Biological Survey were carrying fleas identified by the writer as *C. i. inæqualis* Baker and *Odontopsyllus dentatus* Baker. The host record is new for Oregon.

As new from Oregon at this time the writer wishes to describe

NEARCTOPSYLLA JORDANI TRAUBI, a new subspecies

There are before the describer at this time the holotype male and allotype female and seven paratype females. The new flea is close to *Nearctopsylla jordani* Hubbard 1940 from which it is separated and from which it differs in the male in the armature of the IX sternite. Whereas in *N. jordani* this armature consists of orderly arranged stout bristles in *N. j. traubi* the arrangement is unorderly and the bristles are both stout and long curved, mixed. In the female the VII st. outline and the spermatheca differ from *N. jordani*. In the new flea the outline of VII st. has two sharp processes close together, the shorter one below. *N. jordani* has but one of these processes. The spermatheca of *N. jordani* has body directly running into appendix but in *N. j. traubi* the body is shorter and is definitely cut off from the appendix by a constriction. The appendix is more hooked.

This flea which was taken at Sandy, Clackamas County, Oregon (type locality) on June 23, 1942 off *Scapanus townsendi* (type host) is a true mole flea with range probably east of Willamette River in northern Oregon. The male is 2.50 mm. long, the female 3.00 mm.

The holotype and allotype are mounted on one slide bearing the writer's number 1934 and deposited in the U. S. National Museum. Paratypes are sent to Los Angeles Country Museum, British Museum and California Academy of Sciences. The new

flea bears the name of Major Robert Traub of the Army Medical Department.

CALIFORNIA: Because of the great works by Gus Augustson on fleas in central and southern California, the writer passed through this section only once, on his way to headquarters from southern Nevada. It was pure chance that in Kern County this early spring day a Nelson Ground Squirrel presented too good a mark to miss and when its fleas were examined there turned up a Thrassis with the most distinct finger the writer had ever seen. To commemorate the works of Augustson in this part of California the new flea shall be called

THRASSIS AUGUSTSONI, a new species

There is before the writer at this time only the holotype male. It belongs to that group of Thrassis which have the two modified bristles on the VIII sternite of the male, and seems to be close to *Thrassis gladiolis.* As stated above the finger is distinct both in shape and armature.

Modified Segments: The process of the clasper is typically Thrassis. The very characteristic finger might be described as being plow share shaped when viewed upside down. The posterior border is armed with, below, the usual 2 stout characteristic Thrassis bristles, followed above by a second pair of bristles not so stout, then a bristle much longer than the lower ones, then a weak bristle and then the usual very long one, which is a long way from the apex, the distance between studded with 3 or so equidistant minor bristles. VIII sternite not particularly prominent but armed with the usual curved, stout bristle at the apex and below it the 2 modified bristles which in this case are grass blade shaped. The IX sternite is apically angulate and armed with 3 short apical bristles and below them several much longer ones.

The writer did not secure the female.

The male is small, measuring only about 1.50 mm. in length. The type locality is east of Bakersfield in Kern County, California and the type host is Nelson's Ground Squirrel (*Citellus n. nelsoni*). It seems likely that this is a winter flea of Nelson's Ground Squirrel, so not turned up in plague investigations which are usually carried on at other seasons of the year. The range of the new flea may prove to be throughout the range of the type host. The holotype is mounted on a slide bearing the date March 28, 1948 and is deposited in the United States National Museum.

NEVADA. The next of the new fleas is a winter flea found on kangaroo rats and shall be called

THRASSOIDES HOFFMANI, a new species

This is the third of the strictly winter fleas of kangaroo rats to be described. Prince in 1944 described off kangaroo rats *Th. campestris* in the Great Plains region, *Th. aridis* in southern Arizona and the species before the writer at this time comes from west of the Rocky Mountains. These fleas appear in late fall on kangaroo rats and mice that frequent their range, become very abundant during winter and fade out during spring.

A good series lies before the writer at this time, the specimens personally collected. They come from the southern half of Nevada, east of Death Valley in California, in southwest Utah and northwest Arizona. The selected types are from Beatty, Nye County, Nevada.

Modified Segments: male. Process of clasper well rounded, dome shaped apically armed with a strong bristle and several weak ones. Finger not plump as in *campestris* and *aridis* but slender and about as long as process is high, slightly broader at base than tip, and apically tipped with the characteristic minute spiniform. Posterior border armed below with 2 long strong bristles, not short and stout as in Thrassis. Between these lower bristles sometimes a medium one. Above along margin another 2 long slender bristles, the uppermost the longest and close to the apex a small bristle. VIII sternite differing from *aridis* and *campestris* in being apically broad and flat, the armature consisting of 2 very heavy, longish bristles and 1 short bristle. Lower lobe of IX sternite rounded and armed with the 2 usual curved medium bristles and several minor bristles.

Female: The apical outline of the VII sternite of the female is variable. The small lobe on the slanting surface through its variation covers all stages from the small lobe of *aridis* to the expressed lobe in *campestris*. The armature consists of a posterior row of 8 major bristles and anterior to it a row of 4 medium bristles. The spermatheca is very large, and shaped more like that of *Opisocrostis idahœnsis* rather than any Thrassis and can be described as, body slightly pear shaped, bulge of pear towards outlet, appendix well crooked, finger-like and terminally ending in well defined appendage.

This is the largest of the 3 winter fleas of kangaroo rats, the male measuring 2.75 mm., the female 3.00 mm.

The pair selected as types by the writer were taken at Beatty, Nye County, Nevada, which is the type locality, and the type host is designated as *Dipodomys deserti deserti* but the flea is usually at home on other kangaroo rats in its range.

The new flea probably ranges south of Walker Lake in Nevada

and adjacent California, Utah, and Arizona. West probably of Rocky Mountains and Colorado River north of Colorado Canyon, Arizona.

The holotype male and allotype female are mounted on one slide bearing the writer's number 2579, dated December 30, 1946, collected at Beatty, Nye County, Nevada, and deposited in the United States National Museum. Paratypes are deposited in all maintained depositories of the writer. The flea bears the name of Mr. Floyd Hoffman of Newberg, Oregon, long time friend of the writer and who has been instrumental in helping the writer secure many rare Oregon fleas from that part of Oregon.

The third of the new fleas is the southwest representative of the species *Monopsyllus wagneri* and shall be called

MONOPSYLLUS WAGNERI KYLEI, a new subspecies

There are before the writer at this time a good series of the new flea from east of Death Valley in California, and southern Nevada. Because it was first taken by the writer in Kyle Canyon, northwest of Las Vegas in the Spring Mountains of Clark County, Nevada, it is called *kylei.* The closest ranging subspecies is *Monopsyllus wagneri wagneri* which the writer has from some 300 miles to the north at Carson City, Nevada. *Kylei* is probably most closely related, then, to the prototype found in northern Nevada. The two fleas differ in the modified segments, these differences being: male, whereas the finger in *M. w. wagneri* is apically squarish, in *M. w. kylei* the apical part of the finger is dome shaped. Female, in *M. w. wagneri* the squarish lobe of the apical outline of the VII sternite is cut to the ventral by a well defined bay, this bay being found in specimens of *M. w. wagneri* all through the northwest. In *M. w. kylei* this bay is missing.

In all other features *M. w. kylei* is similar to *M. w. wagneri.*

The type locality is Kyle Canyon, Clark County, Nevada, the type host the Deer mouse, *Peromyscus maniculatus sonoriensis.* The writer has enough materials designated as paratypes that a male and female mounted on a single slide will be deposited in all his maintained depositories. The holotype male and allotype female are also mounted on a single slide which bears the writer's number 2396 and the collection date June 25, 1945, and is deposited in the United States National Museum.

UTAH and ARIZONA. The writer has taken *Thrassoides hoffmani* off kangaroo rats in December in southwestern Utah and northwestern Arizona. *Monopsyllus w. kylei* is also in the writer's collection from these localities off Deer Mice.

The 6 fleas described here as new bring to 32 the number of North American fleas described by the writer.

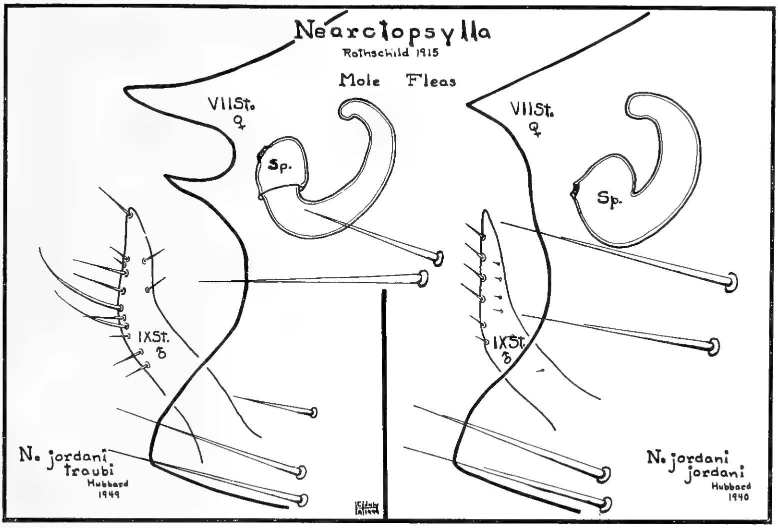


PLATE 5

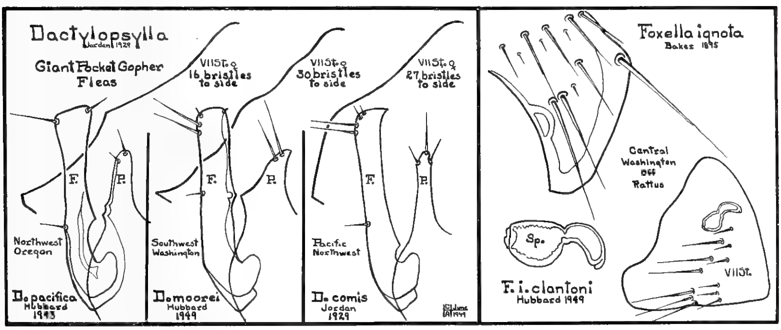


PLATE 6

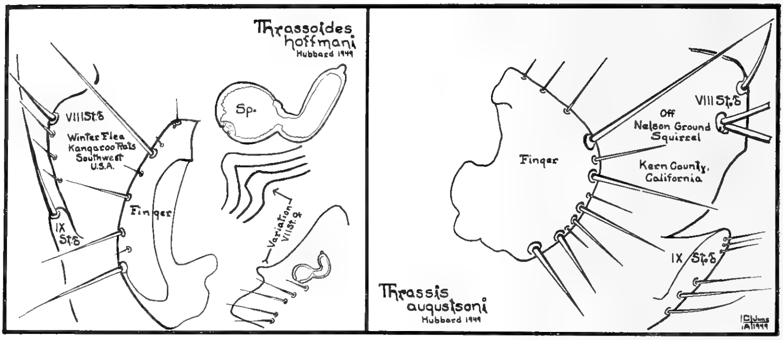


PLATE 7

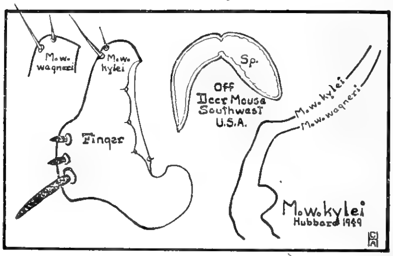


PLATE 8

FOSSIL ARTHROPODS OF CALIFORNIA

17. THE SILPHID BURYING BEETLES IN THE ASPHALT DEPOSITS. W. Dwight Pierce.

The most continuous death traps in existence are the asphalt pits and seeps of the world. In some areas these deposits have been trapping animals and plant materials continuously since Middle Pleistocene times. Much has been written on the findings of bones and other remains of ancient life in the asphalt, but too little stress has been put upon the processes, which took place before the bones were finally incorporated as a part of the asphalt.

Between the living struggling animal and the final deposition of the separated bones of its skeleton in the asphalt, many things took place, and many agencies were at work. In this article one group of these agents of decomposition is to be critically studied, but first it is desirable to insert into the annals of paleontology a sketch of the periods of decomposition of animal bodies as worked out in medical jurisprudence and sanitary entomology.

THE PERIODS OF DECOMPOSITION OF ANIMAL BODIES

When an animal dies, a whole series of changes set in, and these have been divided into periods of decomposition by Mégnin and others, principally for use in legal problems, but also for guidance of undertakers. The timing of the periods naturally varies with temperature, humidity, and atmospheric pressure. In warm climates, decomposition is more rapid, and the periods are shorter. In cold climates they are comparatively longer. In dry climates desiccation will take place earlier.

Because the insects of each period of decomposition are characteristic of that period, we have a criterion to judge as to the time that a carcass was exposed before complete submergence in the asphalt.

It will be recalled that the study of the remains in the La Brea and McKittrick asphalt fields shows that flesh was completely removed or digested in the processes that took place; that horn and nails disappeared, but that occasionally hairs and tiny feather fragments survived. Insect chitin; mollusc and crustacean shell; plant tissues, especially seed coverings; all kinds of bones, sometimes ligaments, survived the processes of disintegration. Colors of insects were not altered as a rule; even setæ on insects occasionally remain.

The reasons for these survivals and disappearances can readily be found in the descriptions of decomposition to follow.

Mégnin's eight periods of progressive decomposition are based on exposed human bodies in France, in which different chemical substances are formed, and different bacteria and insects are at work. In general we can assume that the periods will be approximately the same for all animals, but that the time may also be governed by the size or bulk of the body as well as by climatic considerations.

In California asphalt deposits we may expect three degrees of atmospheric moisture to have a bearing on the relative condition of the bones and plant materials, rating Carpinteria at the side of the ocean most humid, La Brea Pits next, and McKittrick as driest.

Likewise the speed of submergence was governed by depth of the asphalt liquid, which was greatest at Carpinteria and La Brea Pits and least at McKittrick.

Inasmuch as this information has not entered the literature of paleontology I am digesting the data from many sources, because it may explain many things in our study of the life caught in these deposits.

PERIOD I. Body fresh. Internal decomposition is taking place in the nature of autolysis, brought about by the action of the body's own enzymes, breaking down proteins into amino-acids and other substances. In this period, the blue-bottle flies, *Calliphora vicina* Robineau-Desvoidy (*erythrocephala* Mèigen), and *C. vomitoria* Linnæus, are present at the moment of death, and soon afterwards the lesser housefly, *Muscina stabulans* Fallén, and the house fly, *Musca domestica* Linnæus appear. Many fly puparia belonging to this and the next period have been obtained by washing out the skulls of saber-tooth tigers, *Smilodon,* and will be reported on when studied. One species was described in Article 8 of this series.

Fly larvæ secrete amylase, lipase, and protease, ferments which digest the tissues, and the liquefied tissues are taken up by the larvæ.

PERIOD II. Decomposition commences during the first three months. This is usually accomplished by bacteria which break down various amino-acids into ptomaines. The amino-acid, lysine, is broken down into the foul smelling cadaverine or pentamethylene diamine, $NH_2.(CH_2)_5.NH_2$. This happens in the earlier stages of decomposition and may be the product of *Proteus vulgaris.*

As soon as the odor of decomposition becomes evident, the flesh flies of the genus *Sarcophaga* appear. *Lucilia* spp., the green-bottle flies, appear at the initiation of gas formation (cadaveric emphysema).

The amino-acid, ornithin, is broken down into the poisonous, ill-smelling putrescine, or tetramethylene diamine, $NH_2.(CH_2)_4.NH_2$. This reaction takes place in the later stages of the putrefactive decomposition.

The amino-acid, tyrosine, breaks down into tyramine, $NH_2.(CH_2)_2.C_6H_4OH$, commonly found in cheeses.

The very poisonous amino-acid tryptophane breaks down into skatole, C_9H_9N, and indole, C_8H_7N. This is accomplished by bacteria of the *Escherichia colon,* and *Proteus* groups.

The amino-acid, histidine, breaks down into the very poisonous histamine, $C_3H_3N_2$, $(CH_2)_2.NH_2$.

The amino-acid, cystine, breaks down into ethyl mercaptan, C_2H_5SH. Some of these reactions probably belong to the later periods.

PERIOD III. Formation of fatty acids, and beginning of caseous product formation takes place in the third to sixth month. The fatty acids have the general formula $C_nH_{2n}O_2$, or $C_{n-1}H_{2n-1}.CCOH$.

The principal fatty acids are: cerotic (n=26), lignoceric (n=24), behenic (n=22), arachidic (n=20), stearic (n=18), margaric (n=17), palmitic (n=16), capric (n=10), nonylic (n=9), caprylic (n=8), heptylic (n=7), caproic (n=6), valeric (n=5), butyric (n=4), propionic (n=3), acetic (n=2), formic (n=1).

The insects present are *Dermestes* spp., and the moth *Aglossa pinguinalis,* which are attracted to fatty substances.

Numerous *Dermestes* elytra have been recorded from the La Brea pits. These beetles destroy skins and even horn, as well as dry flesh.

PERIOD IV. Formation of caseous products, such as adipocere (grave wax), in the third to sixth months.

The insects usually present are the ham beetles, *Korynetes* spp.; *Necrobia* spp.; the cheese skipper, *Piophila casei* Linnæus; *P. petasionis* Dufour and *Anthomyia* spp. None of these have as yet been identified from the asphalt.

PERIOD V. Ammoniacal fermentation, black liquefaction in

the fourth to eighth months. Ammonia may be produced by the action of such forms as *Bacillus mycoides, Proteus vulgaris, Bacillus megatherium,* and *B. ceres.*

The beetles of the genera *Ophyra, Silpha, Necrodes, Nicrophorus, Hister,* and *Saprinus,* and flies of the genera *Phora* and *Lonchœa,* are present in this period.

The present article discusses the species of *Nicrophorus* and *Silpha* so far recovered from the asphalt. Several species of Histeridæ will be reported on later.

PERIOD VI. Desiccation, in the sixth to twelfth months. The visitors are principally mites (Acarina), and none have been recovered from the asphalt.

PERIOD VII. Extreme desiccation, one to three years. The insects are the same which destroy dried animal and vegetable matter in our homes, and none have been recovered from the asphalt.

PERIOD VIII. Debris, over three years. The insects are Ptinidæ and Tenebrionidæ. Many kinds of Tenebrionidæ have been recovered, but their relationship to carcasses is not evident.

From this we find that the insects of the first five stages of decomposition are present in the asphalt, and we therefore assume that the complete submergence of carcasses was quite slow, possibly even up to five months being required at La Brea Pits. At McKittrick the first seven stages of decomposition can be observed in the present day seep.

FAMILY SILPHIDÆ

Only twelve valid species of fossil Silphidæ have been heretofore reported, according to Dr. Melville Hatch (Jour. New York Ent. Soc. 35:331-371, particularly 365-371).

From the standpoint of a paleoentomologist, the classification of the insects of the genus *Nicrophorus* is very unsatisfactory, being to a large extent a matter of color pattern. When structural characters are used, they deal with only a few parts of the skeleton, and are useful only when one has those parts.

The genera *Silpha* and *Nicrophorus* extend around the Northern Hemisphere, many European-Asiatic species extending into the United States, some as far south as California. *Silpha ramosa* and *S. lapponica* extend into Mexico, but the genus *Nicrophorus* is absent from Mexico and Central America. We have then a group of insects in two genera, which are definitely Nearctic-Palearctic in distribution.

SUBFAMILY SILPHINÆ
TRIBE SILPHINI

GENUS SILPHA LINNÆUS

Up to the present time our evidences of this genus are confined entirely to 17 elytra and elytral fragments representing two species, now classified in different subgenera. One of these species extends from Europe and Asia through Alaska to Mexico, the other is American only.

SILPHA (THANATOPHILUS) LAPPONICA HERBST (Figures 1, 2).

Four right elytra (one perfect, two almost complete, one humeral fragment) from Pit A, one left elytron from Pit X (a lot of material from which the label was lost), four right elytra from Pit Bliss 29.

This is a necrobious insect occurring in Europe, Asia, Alaska, Greenland, Northwest Terr., Labrador, Pennsylvania, District Columbia, Michigan, Wisconsin, Iowa, Kansas, New Mexico, California, and Mexico.

The elytra (figs. 1, 2) have never been described in accordance with standard wing nomenclature. The costal margin is the deeply incised scutellar-sutural margin. Costa, subcosta and radius form the sutural edge, costa crossing underneath, and lying side by side with radius on the underside. The three veins on the remigium or disc are evident both above and below and constitute the two branches of medius and the cubitus. The lateral dorsal portion which is depressed is the vannus, marked by a row of punctures in the depression (Vannus 1), and defined on the lateral margin by Vannus 2. The jugum is beneath infolded from base to apex.

The two medial veins are sharp ridges, bordered on one side in specimen *C3d,* and on each side in the other specimens, by closely set deep punctures; the cubital vein is even more sharply ridged, but not bordered by punctures. The interspaces radiomedial, medial, medio-cubital, and cubito-vannal, contain rows of round tubercles. Second medial and cubital unite apically to form a wiggling ridge, and first medial is also apically hooked in specimen *C3b,* but not in the others. Specimen *C3d* is illustrated.

A comparative study of 2 ♂ and 2 ♀ from Skagway, Alaska, and 2 ♂ and 2 ♀ from Bodega, California indicates a great variation even between elytra on a single individual, in the number of tubercles per interspace. With these are compared the eight fossil elytra and it will be seen that the pattern is too variable to warrant varietal separation on elytral tuberculation alone. The fossil material ranges between the Bodega modern and the Skagway modern, and hence is within the range of the species as now classified.

TUBERCLES PER INTERSPACE IN SILPHA LAPPONICA ELYTRA

SINGLE ELYTRA	Sex	1 Radio-medial	2 Medial	3 Medio-cubital	4 Cubito-vannal
MODERN SPECIMENS:					
Skagway, Alaska 1	♂	9	7	10	10
2	♂	10	11	11	10
3	♀	8	8	6	8
4	♀	9	9	7	12
mean	—	9	8.7	8.5	10
Bodega, Calif. 1	♂	7	5	4	4
2	♂	8	7	5	8
3	♀	8	8	7	7
4	♀	8	5	6	9
mean	—	7.7	6.2	5.5	7
FOSSIL SPECIMENS:					
Pit X. *C3a*	—	8+	9+	10	9*
Pit A. *C3b*	♂	9	8	6	9
C3c	—	8+	6+	6+	9+*
C3d	♀?	6	8	10	8
Pit 29. *C3f*	♂	8	9	10	9
C3g	♀	9	9	11	8
C3h	—	7+	7+	7+	10*
C3i	—	6+	5+	4+	6+*
MEAN 8 FOSSIL (whole ones only)	—	8	8.5	9.4	8.8
Mean 8 recent	—	8.3	7.4	7.0	8.5
Mean 6 ♂	—	8.5	7.8	7.6	8.3
Mean 6 ♀	—	7.5	7.8	7.8	8.6

*Incomplete.

The measurements of the specimens are as follows:

SPECIMEN		LENGTH	BREADTH
Pit X. *C3a*	—	8.6 mm.	3.7 mm.
Pit A. *C3b*	♂	8.1	3.1
C3c	—	—	3.3
C3d	♀?	7.7	3.2
Pit 29. *C3f*	♂	8.0	3.0
C3g	♀	8.8	3.6
C3h	—	—	3.4
C3i	—	—	2.9
mean	—	8.2	3.27

The sexual differences in the elytra may have been noted, but not in any references before me. The female elytron is definitely lobately prolonged on the sutural apex, while in the male the apical margin is very moderately sinuate, without forming the semblance of a lobe.

SILPHA (HETEROSILPHA) RAMOSA SAY 1823
(Figs. 3a, 3b)

Three left elytra, one left fragment, two right elytra with broken tips, one right elytron entire but in two pieces from Pit Bliss 29, and one broken right elytron from Pit A, total 8 specimens, maximum 5 individuals.

This species occurs in Wisconsin, Arizona, Southern California, Baja California, and Mexico proper.

The name *ramosa* is well given, because the two medial and the cubital veins are ridged and laterally branched like the branches of a tree. The material at hand cannot be separated from the modern species.

The under side of the elytra is a metallic green, while the outer surface is black with a faint greenish tinge. While the raised striæ above do not show their origin, on the under side the first two are clearly branches of medius extending to the axillæ. The third stria is the cubitus. The jugum or shoulder and clasping edge is flattened at shoulders, and then raised to the clasping edge.

The tips of the elytra are of two types, one acute (♀) in *C1c. e, f,* and the other rounded (♂) in *C1a.* See figures 3a, 3b.

TRIBE NICROPHORINI

GENUS NICROPHORUS Fabricius

This genus is present at McKittrick and at Los Angeles, there being several distinct species in the asphalt. At present 70 heads, 63 pronota, 12 tibiæ, 6 scutella, and 20 elytra have been separated out, representing 96 individuals at least.

There are two types of scutellum, four types of elytra, three types of pronotum, two types of head in the series, and the heads can be divided by sex.

The first and most important fact emerging from the study of these fragments is that the head capsule of modern Nicrophorus has been wrongly interpreted.

There is necessity for a rectification of an error by Dr. Horn, who interpreted as clypeus all of the area in front of a transverse line in front of the eyes. This line is the frontal suture. In front of this are areas of two textures. He called the anterior portion the "rhinarium." This is the true clypeus, which more or less deeply invades the frons, the two being separated by a very arcuate epistomal suture. The frons becomes a two lobed sclerite with a more or less narrow median bridge.

A study of modern specimens shows a fine sexual character in the shape of these two organs. In the males the clypeus is usually more quadrate with its margin parallel with the margin of the frons so that the frontal bridge is narrow. In the females the clypeus is more apt to be triangular, and the frontal bridge broader, or the clypeus is shallowly rounded. This character should be studied on all modern species. See figures 7, 8, 9, 14 for outlines of the epistomal suture.

In the disintegration of the insect the eyes, antennæ, clypeus, labrum, mandibles, maxillæ, and mentum to labium have been lost. Some of these severed parts are probably chitinous enough to persist and may be found in the microscopic study of the sands recovered from the tar.

This cleavage is along the epistomal, pleurostomal, and hypostomal sutures, and leaves a perfect ring segment, with a definite neck behind the occipital suture. This does not agree with Snodgrass' claims of a segment including clypeus, pleurostoma, gula and postocciput.

If this cleavage is segmental it means that the mouth organs, including clypeus and submentum all belong to one segment, the various parts of which have been subdivided. In other words, the dorsal sclerite consists of clypeus and labrum; the dorso-pleural sclerite, the pleurostome and mandible; the ventro-pleural sclerite, the hypostome and maxilla; the ventral sclerite, the submentum, mentum and labium. The epipharynx and hypopharynx could even be considered as a segment beyond this, which has been drawn in. All of these are separated from the head capsule in the processes of disintegration.

The segment that remains includes dorsally the frons, vertex, epicranium, and postepicranium; dorso-pleurally the parietals, with antennal and ocular sclerites; ventro-pleurally, the genæ; and ventrally, the very narrow gula; behind these the occipital and postoccipital are complete rings.

Melville Hatch in his Studies on the Silphinæ (loc. cit.) divides the genus into various groups based on the shape of the pronotum, and thus assists us in placing the specimens of thoraces in species groups. His key is of no assistance for heads, scutella, elytra, or tibiæ. The only recourse is careful comparisons of mod-

ern species. While the various species differ greatly among individuals in size and color pattern, there is usually a well marked distinction between species. The new characters of frontal and clypeal sexual forms will force a reconsideration of species classification in some groups.

The elytra (figures 4a, 4b) in this genus are not only characterized by the sinuate emargination of the apex, but also by the long slanting costal margin caused by the large scutellum. The humeri are rounded. Externally there is little evidence of the striæ, beyond a few larger punctures, two being faintly indicated by a raised line on the disc, and the third on the upper edge of the lateral declivity. Internally, the raised striæ are much more pronounced. The axillary condyle very clearly shows three prongs, the lower and inner being the first axilla to which costa and subcosta are attached. At the apex of the scutellar emargination there is a notch probably indicating the end of the subcosta, and the twisting over of the costa, at which point radius takes the outer margin with costa margining an infolded strip. The two veins showing externally are the two branches of medius, quite plain on the under side, united near base, and arising from the second axilla. The cubitus is absent. The humerus is quite convex and belongs to the vannal region. The first vannal forms the dorso-lateral ridge and the second vannal the lateral margin of the elytra, both reaching the apex; the vannal area being broad at humeri and gradually narrowed to a point at apex. At the base margining the second vannal vein there is an infolded strip which corresponds to the jugum. The apex of each of the elytra is sinuate from the subacute costal angle to the obtuse vannal angle, and internally it is infolded to a transverse ridge paralleling the margin except in the radial area where it is farther from the margin and straight.

The surface of the elytra is regularly though sparsely and shallowly punctate, with occasional larger punctures.

NICROPHORUS GUTTULUS LABREÆ, new subspecies

(Figures 4 to 10)

One of the difficulties in placing the fossil fragments lies in the proper determination of the modern species. In the Museum collection running to *Nicrophorus guttulus* Motschulsky by the Hatch key, there are two distinct types of male frons and clypeus, the one with the square-cut clypeus dividing frons by a very narrow bridge; and the other in which the clypeus is small and frons has a broad bridge. There is a series with black-clubbed antennæ, and a series with reddish or orange-clubbed antennæ. Obviously the modern species needs some very critical study.

Inasmuch as the material here considered does not completely agree with *N. guttulus guttulus* Motschulsky in the collection, in the range of size of pronotum, shape of prothoracic scutellum, or in the indicated color pattern of elytra, a subspecies name is given for purposes of identification.

The material consists of 8 more or less complete ♂ heads and fragments of 5 more, 13 more or less complete ♀ heads and fragments of 4 more from Pit X; 6 complete ♂ heads, and fragments of 6 more and 21 complete ♀ heads from Pit A; 1 ♀ head from Pit B; 1 ♀ head from undesignated pit; and 2 heads from Pit Bliss 29; totalling 65 heads. There were 24 complete and 5 fragments of pronota from Pit X; 21 complete and 10 fragments from Pit A; 2 pronota from Pit B; 1 from Pit 37; 1 from Pit 28; and 5 complete, 4 partial pronota from Pit Bliss 29; total 73 pronota. Also 4 complete and 3 fragments of elytra from Pit A; one left fragment from Pit X; 2 fragments from Pit 81; 5 scutella from Pit A; one femur, 8 tibiæ from Pit A, and 3 tibiæ from Pit 81. While there are differences in sizes of heads and pronota, it is believed that all of this material represents one form. At least 77 individuals are represented as follows: Pit A—33; Pit X—30; Pit B—2; Pit 28—1; Pit 29—9; Pit 37—1; Pit 81—2.

In describing a fossil species, where the elements were separated, the description must start with the most identifiable part, and in the present state of the keys, the pronotum gives that character.

The pronotum (Figures 5, 6) of this insect is strongly cordate, much broader in front than behind, and is laterally strongly sinuate, without apical angles. The narrow anterior margin is the prescutum, set off from the scutum, by clearcut linear depression. The broad anterior portion of the scutum is defined laterally by a triangular broadening of the margin into a ledge, from which arises the transverse depression or notaulix. This depression crosses the notum and has three forward branches, which divide the anterior portion of notum into two broad quadrate median areas and two lateral parapsidal areas. The posterior ⅔ of the notum is the true scutum. Laterally and posteriorly the notum is flattened into a marginal ledge. Ventrally the tergum has anterior, lateral and posterior folds. The anterior infold is the acrotergite, lenticulate in form.

The ventro-lateral extension of the tergum is divided by the notaulix into an anterior shoulder, which might be termed the prescutal lobe; and a broad lobate part of the scutum corresponding to the suralare of a wing-bearing segment. Posteriorly, and completely concealed externally in the whole insect, though connected with the above mentioned suralare lobe, is the lenticulate scutellum, and a postscutellar bilobed area, actually in front of

the scutellum. The existence of a pronotal scutellum in beetles has not previously been reported. The intersegmental skin is attached to the inner margin of the postscutellum.

Measurements of the pronota attributed to this form range in length on median line from 5.0 to 7.5 mm. (mean 6.0 mm.); in greatest breadth from 5.9 to 9.0 mm. (mean 7.15 mm.); in ratio of length to width from 1 : 1.07 to 1 : 1.28 (mean 1.187).

The head (figs. 7, 8, 9) in this species is readily separable by sex. The male frontal bridge (fig. 7) is narrow, with its anterior margin parallel with the margin of the frontal suture. In the female (fig. 9) the shape of the clypeal indention is more triangular, so that the bridge is narrow only at its median point.

The head has considerable movement, as the long occiput fits deeply into the pronotum and must have a wide intersegmental neck. Dorsally, the occiput has two posterior notches, and the postocciput is a complete invaginated ring. The occiput is a broad ring, cut only medianly beneath by the gular suture. In front of the occipital suture the head is abruptly swollen. Between this suture and the frontal suture above and the hypostomal suture beneath, the vertex, parietals, genæ and gula form a complete ring, with the large eye sockets in the anterior part of the parietals. The vertex is shield shaped, rounded behind, defined by smoother sculpture behind, and in front by two post frontal sutures; medianly the coronal suture is partially indicated. The gula is narrow, defined by the tentorial pits, and acutely terminating in an indistinct suture behind. In front of this solid ring are a number of smaller pieces for attachment of the deciduous appendages. Dorsally, the frons is two pronged, the frontal suture being sinuate, transverse, turning forward at the sides of the frontal processes. The antennal sockets lie at the sides of and outside the frontal lobes immediately in contact with the epistomal suture. Beneath, the central piece is a broad bridge-like hypostoma separating gula from the deciduous mentum; and laterally are two narrow subgenæ for the attachment of the maxillæ.

Thus the cranial capsule consists of four rings: (1) postocciput; (2) occiput, postgenæ, gular suture; (3) vertex, parietals with eyes, genæ, and gula; (4) frons, peristome with antennal sockets, subgenæ, and hypostome. The front outline of this last is the epistomal suture, and the deciduous parts are therefore clypeus and labrum, mandibles, maxillæ, mentum and labium, epipharynx and hypopharynx. Some of these deciduous parts may later be retrieved as the study progresses.

The mesothoracic scutellum (fig. 10) is large and interesting. It has been found five times in the pit A material, varying slightly in size. It is united with the scutum and this internally with the phragma. The scutellum proper is bluntly triangular with the

ratio of breadth at base to length varying from 1:1.09 to 1:1.22 (mean 1.13), base bisinuate, sides sinuate. The scutellum is broader at base than the subquadrate scutum, which is rimmed on all sides and ridged on the median line, basal lateral angles diagonally truncate. The phragma is bilobed, but quite differently from the specimen called *N.obtusiscutellum* (fig. 12).

A total of 6 right and 5 left elytra (Figures 4a, 4b) have been found that are fairly consistent in character. These are uniformly larger than those ascribed to the other species, measuring from 11.5 to 12.1 mm: in length, and 5.2 to 5.6 mm. in width. A faint color pattern is apparent, the red being indistinct: consisting of two transverse bands connected laterally; the anterior complete with a lobe behind; the posterior not reaching the suture, and bilobed. Internally the two forks of the medial vein are distinct. The apex of the elytron is infolded with the inner edge more sinuate than the posterior edge.

NICROPHORUS GUTTULUS GUTTULUS LAJOLLÆ HATCH

Two right and one left elytra from Pit A. The two right elytra measure 9.6 by 4.4 mm.; the left is smaller and measures 7.9 by 3.8 mm. These correspond to Hatch's color variety *lajollæ,* having a basal red spot near the base of the vannus. The vannal ridge is sharp to the humerus. Punctation is clear, linear, but with no indication whatever above of Medius 1 and 2. The punctation is denser just before the smooth apical margin. Inner apex subacute, apical margin sinuate, outer apex obtuse. On the under side the 2 radial, cubital and vannal veins are clearly outlined, the medial being raised. The red vannal spot is clear on the under side.

NICROPHORUS GUTTULUS PUNCTOSTRIATUS, new subspecies

One elytron (*C132b*) from pit A is smaller than those previously discussed, measuring 7.0 by 3.4 mm., and is characterized by transverse double punctures outlining the two median veins and also cubitus.

NICROPHORUS MCKITTRICKI, new species
(Figure 11)

Based on 1 pronotum (holotype), 1 right elytron, 1 left elytron from Site 3, depth 2 ft. at McKittrick; 3 right and 3 left elytra from Site 4, depth 4 ft, at McKittrick; with which are tentatively associated 1 head, 1 pronotum from La Brea pits Pit A; 1 pronotum from Pit 28; 1 pronotum from Pit 29; 3 heads from Pit X; and 1 head from Pit B.

This species probably belongs to the *marginatus* group, possibly near *guttulus,* but the shape of the thorax (Figure 11) is different, being much less sinuate on the sides. The median impression on pronotum is distinct; the flattened posterior area is not rounded regularly as in *guttulus labreæ,* but has two lateral angular processes into the convex area. Pronotum *McK3a* measures 4.72 mm. in length by 5.20 mm. breadth, or a ratio of length to breadth 1 : 1.101.

The elytra measure 8.1 by 3.8 mm., ratio 2.13:1. Vannal ridge extends to a point opposite the humeral angle; punctation is shallow, with no external indication of veins; the inner apical angle is slightly acute. On the inside the veins are distinct.

NICROPHORUS OBTUSISCUTELLUM, new species (Figure 12)

One scutellum from Pit A differs so radically from that of *C. guttulus labreæ* and from any scutellum in the Museum's modern collection that it is given name pending its correlation with other materials to be later found. The scutellum proper measures 3.04 mm. in length by 3.84 mm. in breadth.

NICROPHORUS INVESTIGATOR ALPHA, new subspecies (Figure 13)

Described from five complete and one fragmentary pronota from Pit A, obviously belonging to the *N. investigator* series. No other parts are as yet clearly associated with this species. The form belongs near to *N. i. nigritus,* and one specimen has the same ratio of length to width as a modern specimen from Pasadena.

They vary in length from 4.16 to 5.44 mm., in breadth from 6.24 to 7.52 mm., and in ratio of length to width from 1:1.27 to 1:1.50. This thorax is subquadrate with the posterior angles diagonally truncate, the median sulcus distinct, the flattened areas broad and irregular.

One head (*C120d*) from Pit X somewhat resembles heads in the Museum collection of *N. investigator,* and so it is tentatively called NICROPHORUS INVESTIGATOR LATIFRONS, new subspecies (Fig. 14).

ILLUSTRATIONS

Figure 1. *Silpha lapponica* Herbst elytron; dorsal view of specimen *C3d*, with outlines of the apex of ♂ *C3f* and ♀ *C3g*. *Cu*—cubital vein; *Ju*—jugum; *M1, M2*—medial veins; *R*—radius; *SC*—subcosta; *V1, V2*—vannal veins.

Figure 2. *Silpha lapponica* Herbst elytron, under side.

Figure 3. *Silpha ramosa* Say. *a.* tip of ♂ elytron (*C1a*); *b.* tip of ♀ elytron (*C1c*).

Figure 4. *Nicrophorus guttulus labreæ* Pierce elytron (*C3d*). *a.* upper side; *b, under side. A1, A2, A3*—articular condyles; *Af*—apical fold; *C*—costa; *Ju*—jugum; *M1, M2*—medial veins; R—radius; *SC*—subcosta; *V1, V2*—vannal veins.

Figure 5. *N. g. labreæ* pronotum (*C2 f*). *ALS*—anterior lobe of scutum; *LLS*—antero-lateral lobes of scutum or parapsides; *ML*—marginal ledge; *No*—notaulix; *Prs*—prescutum; *Sc*—scutum.

Figure 6. *N. g. labreæ*, underside of pronotum. *Atg*—acrotergite; *ML*—marginal ledge; *Prs*—prescutum; *PrsL*—prescutal lobe; *PS*—postscutellum; *Sa*—suralare; *Scl*—scutellum.

Figure 7. *N. g. labreæ*, head of ♂ (*C2bg*). *As*—antennal sclerite; *Cs*—coronal suture; *Es*—epistomal suture; *Fr*—frons; *Fs*—frontal suture; *Oc*—occiput; *Ocs*—occipital suture; *Ocv*—ocular cavity; *Os*—ocular sclerite; *Pfs*—postfrontal suture; *Ve*—vertex.

Figure 8. *N. g. labreæ*, under side of ♂ head. *Es*—epistomal suture; *Fr.* frons; *Ge*—gena; *Gu*—gula; *Hst.*—Hyposterum; *Ocs*—occipital suture; *Pge*—postgena; *Poc*—postocciput; *Pos*—postoccipital suture; *Tp*—tentorial pits.

Figure 9. *N. g. labreæ*, dorsal view of ♀ head (*C2bf*). As in No. 7.

Figure 10. *N. g. labreæ*, mesonotum (*C2bh*). *IS*—intersegmental skin; *Ph*—phragma; *Scl*—scutellum; *Sct*—scutum.

Figure 11. *Nicrophorus mckittricki* Pierce, pronotum (*McK3a*).

Figure 12. *Nicrophorus obtusiscutellum* Pierce, mesonotum (*C120e*). As in No. 10.

Figure 13. *Nicrophorus investigator alpha* Pierce, pronotum *(C121d).*

Figure 14. *Nicrophorus investigator latifrons* Pierce, dorsum of ♀ head (*C120d*).

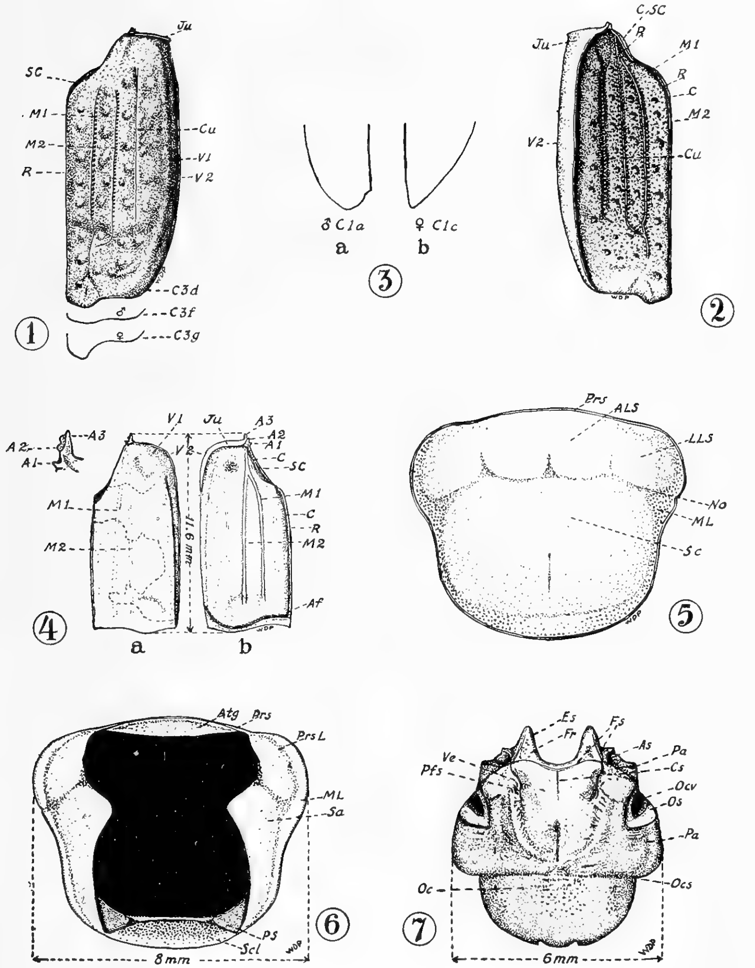

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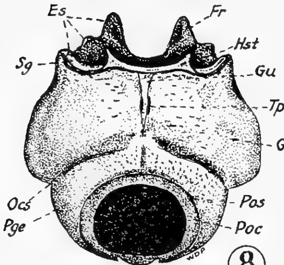
PLATE 9



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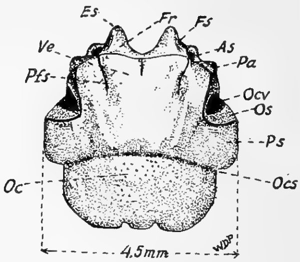

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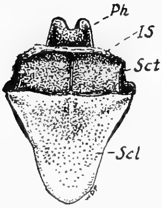

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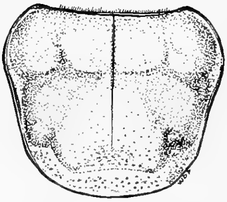

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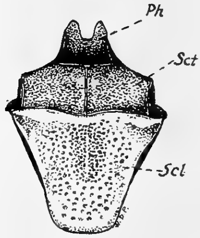

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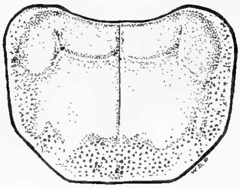

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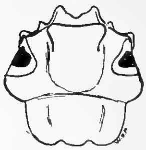

(14)

PLATE 10

ADDITIONAL PYRAMIDELLIDÆ FROM THE GULF OF CALIFORNIA

By A. M. STRONG
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A paper on "Some Pyramidellidæ from the Gulf of California" by Fred Baker, G. D. Hanna and the present writer[1] was published several years ago. The material on which that paper was largely based was collected by Dr. Fred Baker during the Expedition of the California Academy of Sciences to the Gulf of California in 1921. In the paper it is stated that "There was opportunity at times to dredge in shallow waters" and "some small but very rich samples were obtained at a few favorable localities." By some oversight the finer screenings from these localities were stored in the basement of the Academy without being examined to see what minute forms of mollusca it might contain. Later it was found that this material contained a considerable number of small shells. Part of it was sorted out at the Academy and the specimens so secured and the rest of the unsorted material was turned over to the writer for sorting and identification. The specimens found in it form a considerable addition to the number of species of Pyramidellidæ from the Gulf of California in the Academy's collection.

The failure to find these shells when the collection was first gone over is not surprising. The writer has found that securing them when they are present in dredged material requires special treatment. They can seldom be recognized in the wet material and have a tendency, particularly the slender species such as *Turbonilla,* of getting the apex into an opening in the screen and then being pushed on through by the coarser material. Good results can be secured by washing all material brought up by the dredge in a screen having from 20 to 30 wires to the inch in order to get rid of all mud. The material retained on the screen is then thoroughly dried and sized through a set of coarser screens and each size picked over under a hand glass.

Many have questioned the advisability of describing and naming the great number of slightly differing forms of Pyramidellidæ occurring on the west coast until more is known of the limits of variation of what may finally be determined as valid species. Willett in reporting on "An Upper Pliocene Fauna from the Baldwin Hills, Los Angeles County, California"[2] states "Our series of

[1]Baker, F., Hanna, G. D., and Strong, A. M., Proc. Calif. Acad. Sci., 4th ser., vol. 17, No. 7, June 29, 1928, pp. 205-246, pls. 11, 12.
[2]Willett, G., Trans. San Diego Soc. Nat. Hist., Vol. 8, No. 30, December 15, 1937, p. 403.

about 1,000 specimens of the subgenus *Pyrgiscus* clearly demonstrates that many of the features generally used in differentiation of the species in the group are of little value. Variation in number and strength of both spirals and axials are endless. In many groups, undoubtedly of the same species, it is difficult to find two specimens exactly alike. These facts have caused the writer to adopt an entirely different view of the definition of species in the genus *Turbonilla,* with the direct result that no new ones are named in this paper, although there are numerous specimens that are different in appearance from anything hitherto described." Willett had many more specimens than are known from any single locality in the living fauna. His findings may be the result of the examination of the large number of specimens or because he was dealing with a time of active breaking up of old species with the formation of incipient species, many of which have now died out. Of the specimens available to Dall and Bartsch in the preparation of their "A Monograph of West American Pyramidellid Mollusks" some 500 specimens were referred to *Turbonilla* (*Pyrgiscus*) *tenuicula* (*Gould*).[3] They stated that this species "is the most abundant and most variable species of all the west American forms, presenting many varieties or incipient species."

Against this we have the fact that some of the better known west coast species are very constant over a considerable geographic range. They can be recognized with certainty by minor details of sculpture or shape. Some species are wide ranging while others are very local in their distribution. Bartsch stated in connection with the description of a number of species from Santa Elena Bay, Ecuador,[4] that "A very careful comparison of these specimens with the magnificent Panama series in the United States National Museum reveals the fact that every species represented in this gathering proves to be undescribed." In this family we seem to be dealing with species which in some cases are variable in details of sculpture, etc., and in other cases with species in which these characters have become definitely fixed. Most of the described forms are not well enough known for one to state in which category they should be placed. It is not safe to assume that intergrading forms exist connecting any two species simply because they only differ in apparently minor details. It seems to the writer that it is best to continue naming new species wherever definite differences from the previously described forms are found. This will call for a recording of intergrading specimens as they may later be found and in the end will result in defining the limits of variation in any given species, even if it is at the expense of considerable synonymy.

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[3]Dall, W. H., and Bartsch, P., U. S. Nat. Mus., Bull. No. 68, December 13, 1909, pp. 92-93, pl. 8 figs. 3 7, 7a, 12, 12a, 14, 14a.

[4]Bartsch, P. New Mollusks from Santa Elena Bay, Ecuador, Proc. U. S. Nat. Mus., Vol. 66, No. 2551, Art. 14, October 17, 1924, p. 1.

The additional records and new species found in the material secured by the Academy expedition of 1921 follow. Together with these there is included the descriptions of three new species collected by Dr. L. G. Hertlein, two at Mazatlan, and one at Asuncion Island off the west coast of Lower California, Mexico.

1. TURBONILLA (Chemnitzia) amortajadensis Baker, Hanna & Strong.

Turbonilla (Chemnitzia) amortajadensis Baker, Hanna & Strong, Proc. Calif. Acad. Sci., ser. 4, vol. 17, No. 7, June 29, 1928, pp. 209, 210, pl. 11, fig. 2.

A second specimen agreeing with the type was secured at La Paz. Two specimens from San Jose Island, the type locality, have the intercostal spaces extending from suture to suture but seem to agree with the type in all other ways. This difference does not seem to warrant calling them a distinct species, at least until a much larger series can be secured.

2. TURBONILLA (Chemnitzia) muricata (Carpenter)

Chemnitzia muricata Carpenter, Cat. Mazatlan Shells, December, 1856, p. 428.

Turbonilla (Chemnitzia) muricata (Carpenter), Dall & Bartsch, U. S. Nat. Mus., Bull. No. 68, 1909, p. 36, pl. 2, fig. 9—Baker, Hanna & Strong, Proc. Calif. Acad. Sci., ser. 4, vol. 17, No. 7, 1928, p. 210, pl. 11, fig. 3.

Carpenter reports the type and four specimens from off *Spondylus* at Mazatlan and Dall & Bartsch repeat the record. These *Spondylus* were probably shipped into Mazatlan from some other point in the Gulf such as the pearl banks near La Paz. In the previous paper specimens are recorded from Monserrate Island. To this record is now added three specimens from La Paz.

3. TURBONILLA (Chemnitzia) sinaloana Strong, new species

Plate 12, Figure 2

Shell small, elongate-conic, very slender, translucent, white; nuclear whorls helicoid, with a projecting apex, set at right angles to the succeeding whorls in the first of which they are about one-third immersed; postnuclear whorls nine, at first narrowly, roundly shouldered, later closely appressed at the suture moderately rounded: axial sculpture of strong, protractive, distinctly sinuous ribs of which fourteen appear on the first whorl, increasing to eighteen on the last whorl; intercostal spaces about twice as wide

as the ribs, terminating at or slightly above the periphery; spiral sculpture absent; periphery and base well rounded; smooth except for fine, microscopic lines of growth; aperture defective in the type. The type measures: length, 2.9 mm.; maximum diameter, 0.8 mm.

Holotype, No. 9467 (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Loc. 27223 (C. A. S.), Mazatlan, Mexico; collected by L. G. Hertlein.

This species resembles *Turbonilla* (*Chemnitzia*) *aculeus* (C. B. Adams)[5] in many ways but is a smaller shell with narrower, more sinuous axial ribs.

4. TURBONILLA (Stroiturbanilla) c-b-adamsii (Carpenter)

Chemnitzia C.-B.-Adamsii Carpenter, Cat. Mazatlan Shells, December, 1856, p. 427.

Turbonilla (*Strioturbonilla*) *c-b-adamsii* (Carpenter), Dall & Bartsch, U. S. Nat. Mus., Bull. No. 68, 1909, p. 52, pl. 3, fig. 3.—Baker, Hanna & Strong, Proc. Calif. Acad. Sci., ser. 4, vol. 17, No. 7, 1928, p. 211.

Carpenter records 13 specimens of this species collected off *Chama* and *Spondylus* at Mazatlan and Dall & Bartsch repeat the record. In our previous paper one specimen from the "Gulf of California" is recorded but there is also recorded (p. 210) specimens of *Turbonilla* (*Strioturbonilla*) *buttoni* Dall & Bartsch[6] from San Luis Gonzago Bay, La Paz, Monserrate Island and San Jose Island. Examination of additional specimens from San Luis Gonzago Bay, La Paz, Puerto Escondido, Concepcion Bay and San Francisquito Bay make the latter identification doubtful. The only noticeable difference between the Gulf *c-b-adamsii* and the California *buttoni* seems to be in size. The type of the first is an immature shell of 9 whorls measuring 3.75 mm. in length. An adult from San Luis Gonzago Bay with 11 whorls measures 5.0 mm. in length. The type of *buttoni* from San Pedro, California. also has 11 whorls but measures 6.3 mm. in length. In the key[7] by Dall & Bartsch, the species are separated by having the "Intercostal spaces terminating posterior to the periphery, having a plain, smooth band in the suture" in *buttoni* and "Intercostal spaces extending to the suture" in *c-b-adamsii*. This is not a constant character in either the California or the Gulf shells. Another

[5] *Chemnitzia aculeus* C. B. Adams, Ann. Lyceum Nat. Hist. New York, Vol. 5, July 1852, pp. 388, 535 (separate, pp. 164, 311).—Dall & Bartsch, U. S. Nat. Mus., Bull. No. 68, 1909, p. 38, pl. 2, figs. 2, 2a (as *Turbonilla* (*Chemnitzia*) *aculeus*).
[6] U. S. Nat. Mus., Bull. No. 68, 1909, p. 43, pl. 3, figs. 4, 4a.
[7] U. S. Nat. Mus., Bull. 68, 1909, pp. 40, 41.

difference given in the description is in the spiral sculpture. In both forms this is very variable, in some specimens entirely absent and in others easily visible with a hand lens. They are both shore or shallow water species and there is a long stretch of shore line between Pt. Abreojos on the outer coast of Lower California and La Paz on the Gulf coast from which neither have as yet been reported. It is probably best to refer all Gulf specimens to *c-b-adamsii* and retain *buttoni* for the California shells, though the latter might well be reduced to a variety.

5. TURBONILLA (Strioturbonilla) mexicana Dall & Bartsch

Turbonilla (*Strioturbonilla*) *mexicana* Dall & Bartsch, U. S. Nat. Mus., Bull. No. 68, December 13, 1909, p. 45, pl. 3, figs. 5, 5a.—Baker, Hanna & Strong, Proc. Calif. Acad. Sci., ser. 4, vol. 17, No. 7, 1928, p. 210.

In the original description 14 specimens are listed as dredged in the vicinity of La Paz. In our previous paper 1 specimen was recorded from West Anchorage and 1 from Amortajada Bay, San Jose Island. In the additional material there are 4 specimens from Puerto Escondido, 1 specimen from Concepcion Bay and 3 specimens from the Gulf of California without definite locality.

6. TURBONILLA (Stroiturbonilla) nicholsi Dall & Bartsch

Turbonilla (*Strioturbonilla*) *nicholsi* Dall & Bartsch, U. S. Nat. Mus., Bull. No. 68, December 13, 1909, pp. 46, 47, pl. 3, fig. 2.

The type is stated to have been collected in the Gulf of California without definite locality. A few specimens from San Luis Gonzaga and La Paz, while smaller than the type and with fewer whorls, seem to belong to this species.

7. TURBONILLA (Strioturbonilla) schmitti Bartsch.

Turbonilla (*Strioturbonilla*) *schmitti* Bartsch, Proc. U. S. Nat. Mus., vol. 52, No. 2193, May 29, 1917, p. 644, pl. 43, fig. 8.—Baker, Hanna & Strong, Proc. Calif. Acad, Sci., ser. 4, vol. 17, No. 7, 1928, p. 211, pl. 11, fig. 4.

The type locality for this species is Point Abreojos on the outer coast of Lower California. In our previous paper specimens from Cape San Lucas and San Francisquito Bay are referred to this species and certain minor differences are pointed out. In the additional material there are specimens from San Francisquito Bay, La Paz and San Jose Island, also showing these same minor differences.

8. TURBONILLA (Strioturbonilla) asuncionis Strong, new species.

Plate 12, Figure 6

Shell small, elongate-conic, translucent, white; nuclear whorls smooth, forming a helicoid spire with a low apex not projecting beyond the outline of the spire, and about one-fourth immersed in the first postnuclear whorl; postnuclear whorls eight, moderately rounded; axial sculpture of high, sinuous, protractive ribs which are truncated and slightly swollen at the suture and pass feebly over the periphery; of these ribs there are fourteen on the first whorl, increasing to twenty on the last whorl; intercostal spaces a little wider than the ribs, ending a little above the periphery, leaving a smooth band at the sutures; spiral sculpture of very fine, microscopic striations showing most distinctly on the sides of the ribs; base well rounded, showing fine, irregular lines of growth; aperture rather long, with the outer lip parallel to the columella, basal lip a little expanded; columella straight, without a visible fold at its insertion. The type measures: length, 3.4 mm.; maximum diameter, 1.0 mm.

Holotype, No. 9468, and paratypes, Nos. 9469, 9470 (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Loc. 27245 (C. A. S.), Ascuncion Island, Lower California; collected by L. G. Hertlein. Eight additional specimens were secured at the same locality.

This species is quite similar to *Turbonilla c-b-adamsii* (Carpenter)[8] but possesses a thinner, more delicate shell, with less distinct spiral striæ, and the supra-sutural band is developed while on *c-b-adamsii* it is absent or very narrow. It may prove to be an extreme variety of that variable species.

9. TURBONILLA (Pyrgolampros) gonzagensis Baker, Hanna & Strong.

Turbonilla (Pyrgolampros) gonzagensis Baker, Hanna & Strong, Proc. Calif. Acad. Sci., ser. 4, vol. 17, No. 7, June 29, 1928, pp. 213-214, pl. 11, fig. 7.

In the original description specimens were recorded from a number of localities in the Gulf of California. In the additional material there are 7 specimens from La Paz. These show considerable variation in the spiral sculpture, some have it reduced to 6 or 8 incised lines between the sutures which cannot be followed over the ribs. These would be placed in the subgenus *Pyrgiscus* if it were not for the low, broadly rounded form of the axial ribs.

[8] Carpenter, P. P. Cat. Mazatlan Shells, December, 1856, p. 427—Dall & Bartsch, U. S. Nat. Mus., Bull. No. 68, 1909, p .52, pl. 3, fig. 3.

10. TURBONILLA (Pyrgolampros) pazensis Baker, Hanna & Strong

Turbonilla (*Pyrgolampros*) *pazensis* Baker, Hanna & Strong, Proc. Calif. Acad. Sci., ser. 4, vol. 17, No. 7, June 29, 1928, pp. 214-215, pl. 11, fig. 8.

At the time of the original description this species was represented only by the holotype from La Paz. In the additional material there are 2 specimens from Puerto Escondido and 5 from Concepcion Bay.

11. TURBONILLA (Pyrgiscus) azteca Baker, Hanna & Strong

Turbonilla (*Pyrgiscus*) *azteca* Baker, Hanna & Strong, Proc. Calif. Acad. Sci., ser. 4, vol. 17, No. 7, June 29, 1928, pp. 222-223, pl. 11, fig. 14.

In the original description of this species specimens are recorded from San Luis Gonzaga Bay; also from Coyote Bay, Concepcion Bay, and it is stated "A small spot on the holotype and one paratype is light horn-color, suggesting the probability that the holotype is faded." In the much larger series of specimens in the additional material from Puerto Escondido, San Luis Gonzaga and from the Gulf of California without definite locality this is shown to be correct. In fresh specimens the nucleus and first one or two whorls are translucent white, the following whorls grade into pale brown, darker on the base and just below the sutures where the preceding whorl shines through.

12. TURBONILLA (Pyrgiscus) halidoma Dall & Bartsch

Turbonilla (*Pyrgiscus*) *halidoma* Dall & Bartsch, U. S. Nat. Mus., Bull. No. 68, December 13, 1909, pp. 99-100, pl. 10, figs. 11, 11a.

The holotype is stated to have been dredged in 21 fathoms off La Paz. Two specimens from San Luis Gonzaga seem to agree with the description and figure of this species.

13. TURBONILLA (Pyrgiscus) histias Dall & Bartsch

Turbonilla (*Pyrgiscus*) *histias* Dall & Bartsch, U. S. Nat. Mus., Bull. No. 68, December 13, 1909, pp. 105-106, pl. 10, figs. 8, 8a.

The type and two paratypes were dredged in 21 fathoms off La Paz. In the description it is stated, "posterior half between the sutures light yellow; anterior half of base, chestnut." Four specimens in our material from La Paz agree with the description and figure in size, shape and sculpture. They seem to be quite fresh

and are of a uniform translucent white. A single specimen from Puerto Escondido also seems to belong to the same species but is of a uniform pale brown.

14. TURBONILLA (Pyrgiscus) macbridei Dall & Bartsch

Turbonilla (Pyrgiscus) macbridei Dall & Bartsch, U. S. Nat. Mus., Bull. No. 68, December 13, 1909, p. 90, pl. 8, figs. 13, 13a.—Baker, Hanna & Strong, Proc. Calif. Acad. Sci., ser. 4, vol. 17, No. 7, 1928, 2. 217—Lowe, Trans. San Diego Soc. Nat. Hist., vol. 8, No. 6, 1935, p. 30.

The holotype of this species was dredged in 9½ fathoms off La Paz. In our previous paper a number of specimens were recorded from drift at Espiritu Santo Island and Lowe reports the species dredged in 10 fathoms at Punta Penasco. To these records there is now added one specimen from La Paz and one from Concepcion Bay.

15. TURBONILLA (Pyrgiscus) porteri Baker, Hanna & Strong

Turbonilla (Pyrgiscus) porteri Baker, Hanna & Strong, Proc. Calif. Acad. Sci., ser. 4, vol. 17, No. 7, June 29, 1928, pp. 217-218, pl. 11, fig. 10.

The holotype is stated to have come from the Gulf of California without definite location. A single specimen from San Luis Gonzaga is believed to belong to the species.

16. TURBONILLA (Pyrgiscus) sanctorum Dall & Bartsch

Turbonilla (Pyrgiscus) sanctorum Dall & Bartsch, U. S. Nat. Mus., Bull. No. 68, December 13, 1909, p. 98, pl. 9, figs. 2, 2a.—Lowe, Trans. San Diego Soc. Nat. Hist., vol. 8, No. 6, 1935, p. 31.

In the original description of this species specimens are recorded from off La Paz and off Ceralvo Island. Lowe records the species as dredged in 10 fathoms at Punta Penasco. To these records can be added one specimen from La Paz and two from Concepcion Bay.

17. TURBONILLA (Pyrgiscus) superba Dall & Bartsch

Turbonilla (Pyrgiscus) superba Dall & Bartsch, U. S. Nat. Mus,. Bull. No. 68, December 13, 1909, pp. 80-81, pl. 7, figs. 10, 10a.

In the original description the type and two additional specimens are recorded as dredged off La Paz in 21 fathoms. Two

specimens from Concepcion Bay seem to agree with the description and figure.

18. TURBONILLA (Pyrgiscus) alarconi Strong, new species

Plate 12, Figure 5

Shell small, elongate-conic, the nucleus and first two postnuclear whorls white, the third whorl pale brown, the color rapidly increasing on the following whorls to a uniform brown; nucleus forming a flattened spire with the axis at right angles to that of the succeeding whorls, in the first of which it is about one-fourth immersed; postnuclear whorls eight, moderately rounded; axial sculpture of slightly retractive, low, rounded ribs which pass over the periphery and become feeble in the umbilical region; of these ribs about twenty-eight appear on the first two whorls, twenty on the third whorl and then gradually increasing to about thirty on the last whorl, intercostal spaces about twice as wide as the ribs; spiral sculpture of six to eight spirally elongated pits in the intercostal spaces on each whorl of the spire and a few fine spiral lines between the upper pit and the suture; periphery of the last whorl rounded, marked by a narrow, smooth space; base rounded, with six spiral lines more or less broken into pits by the extension of the axial ribs; aperture oval, outer lip thin, columella short, straight. The type measures: length, 4.5 mm.; maximum diameter, 1.6 mm.

Holotype, No. 9471, and paratype, No. 9472 (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Loc. 23808 (C. A. S.), Concepcion Bay on the Lower California coast in the Gulf of California; also a paratype, No. 9473, from Loc. 23802 (C. A. S.), San Luis Gonzaga Bay, Lower California; collected by Dr. Fred Baker in 1921.

This is one of the few uniformly brown species as yet collected in the Gulf of California. It is probably nearest to *Turbonilla (Pyrgiscus) larunda* Dall & Bartsch[9] but differs in color, size and in the arrangement of the spiral sculpture. The difference in color and sculpture between the first two postnuclear whorls and the remainder of the shell is quite striking in the type.

This species is named for Hernando de Alarcon, Admiral of the Spanish Viceroy Mendoza, who in 1541 sailed to the headwaters of the Gulf of California.

19. TURBONILLA (Pyrgiscus) kaliwana Strong, new species

Plate 11, Figure 6

Shell elongate-conic, slender, white, with a pale brown band a little above the sutures; nucleus with a flattened spire, set at right

[9] U. S. Nat. Mus., Bull. No. 68, December 13, 1909, pp. 109-110, figs. 4, 4a, 4b.

angles to the succeeding whorls, the maximum diameter of which is a little greater than that of the first postnuclear whorl, in which it is slightly immersed; postnuclear whorls eleven, the early whorls well rounded, the latter flattened in the middle; axial sculpture of straight, retractive ribs which pass over the periphery but fade out on the base; of these about eighteen appear on the first whorl, increasing to twenty-eight on the last; intercostal spaces a little wider than the ribs; spiral sculpture of about fourteen irregularly spaced, incised, lines which do not cross the top of the ribs, of these one at the periphery and one or more on the middle of the whorls are deeper and wider than the others but can hardly be defined as a "peripheral and median line of pits;" periphery rounded; base short, rounded, marked with six spiral lines of which the upper appear as a line of pits; aperture small, ovate, outer lip thin, columella short, curving to a junction with a strong callus on the body of the basal whorl. The type measures: length, 6.0 mm.; maximum diameter, 1.2 mm.

Holotype, No. 9474, and paratypes, Nos. 9475, 9476 (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Loc. 23802 (C. A. S.), San Luis Gonzaga Bay on the Lower California coast of the Gulf of California, Mexico. Four additional specimens were collected at the same locality by Dr. Fred Baker in 1921.

This species belongs in a group including *Turbonilla* (*Pyrgiscus*) ceralva Dall & Bartsch[10] and *Turbonilla* (*Pyrgiscus*) *azteca* Baker, Hanna & Strong[11] from the Gulf of California fauna. It differs from both in the less strongly retractive axial ribs which are less well developed on the base and in the arrangement of the spiral sculpture as well as in the color.

The specific name of this species is derived from the tribal name of the Kaliwa Indians, Lower California.

20. TURBONILLA (Pyrgiscus) guaicurana Strong, new species
Plate 12, Figure 1

Shell broadly conic, thin, delicate, white; nuclear whorls large, the apex flattened and the axis forming an angle of about 60° with that of the succeeding whorls in the first of which they are nearly one-half immersed; postnuclear whorls six, flat-sided, strongly, slopingly shouldered near the summit; axial sculpture of nearly vertical ribs which are highest just below the shoulder and pass feebly over the periphery, fading out on the upper part of the base; of these ribs fourteen appear on all whorls; intercostal spaces shallow, much wider than the ribs; spiral sculpture of incised spiral lines which cut across both axial ribs and intercostal spaces, the interspaces between them appearing as flat-topped

[10] U. S. Nat. Mus., Bull. No. 68, December 13, 1909, p. 104, pl. 10, figs. 5, 5a.
[11] Proc. Calif. Acad. Sci., 4th ser., Vol. 18, No. 7, June 29, 1928, pp. 222, 223, pl. 11, fig. 14.

threads; of these spiral lines the upper is midway on the sloping shoulder and is deeply cut, leaving a nodose band between it and the suture, this is followed by three closely spaced lines on the lower half of the shoulder and six wider spaced lines on the flattened portion of the whorl; periphery angulated, base short, rounded, marked with twelve fine spiral threads; aperture defective in the type. The type measures: length, 3.2 mm.; maximum diameter, 1.3 mm.

Holotype, No. 9477 (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from La Paz on the Lower California coast of the Gulf of California; collected by Dr. Fred Baker in 1921.

While the unique type is undoubtedly a young shell it is entirely distinct from anything previously described from the Gulf region. In some ways it resembles *Turbonilla* (*Pyrgiscus*) *annettæ* Dall & Bartsch[12] from Manta, Ecuador, but has a wider shoulder and entirely different spiral sculpture on both base and spire. The specific name of this species is derived from the tribal name of the Guaicura Indians, Lower California.

21. TURBONILLA (Pyrgiscus) aripana Strong, new species
Plate 11, Figure 5

Shell elongate-conic, white; nucleus moderately large, with a flattened apex, the axis at right angles to that of the succeeding whorls, in the first of which it is about one-fourth immersed; postnuclear whorls ten, nearly flatsided, the early ones narrowly, slopingly shouldered, the latter one less so; axial sculpture of low, protractive, rounded ribs which tend to flatten out at the summit and pass feebly over the periphery, of these ribs fourteen appear on the first whorl, increasing to eighteen on the last; intercostal spaces shallow, a little wider than the ribs; spiral sculpture of eight or more rows of pits in the intercostal spaces, varying in number from whorl to whorl but with a tendency to form a deeper and wider series at the periphery and a little above the middle of the whorls; periphery well rounded; base short, rounded, the upper third smooth, followed by nine incised spiral lines; aperature oval, outer lip thin, columella curved, reflected, body of the shell with a strong callus. The type measures: length, 6.0 mm.; maximum diameter, 1.7 mm.

Holotype, No. 9478, and paratypes, Nos. 9479, 9480 (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Loc. 23805 (C. A. S.), Puerto Escondido, on the east California coast of Lower California; collected by Dr. Fred Baker in 1921.

This species is similar in size and shape to *Turbonilla* (*Pyr-*

[12]U. S. Nat. Mus. Bull. No. 68, December 13, 1909, p. 76, pl. 7, fig. 7.

giscus) *halidoma* Dall & Bartsch[13] but differs from it and all other species previously described from the Gulf region in the details of the sculpture.

The specific name of this species is derived from the tribal name of the Aripa Indians, Lower California.

22. TURBONILLA (Pyrgiscus) cochimiana Strong, new species
Plate 12, Figure 4

Shell elongate-conic, slender, light horn color; nuclear whorls decolate but evidently quite large; postnuclear whorls ten, roundly shouldered at the summit, flattened in the middle and strongly contracted at the suture, axial sculpture of low, rounded, retractive ribs which tend to flatten out at the summit and pass feebly over the periphery, of these ribs fourteen appear on the first whorl, increasing to twenty-four on the last whorl; intercostal spaces shallow, about as wide as the ribs; spiral sculpture of eight rows of pits in the intercostal spaces, varying in depth and spacing from whorl to whorl but with a tendency to form a wider and deeper peripheral row; periphery well rounded, base short, rounded, marked with ten incised spiral lines, the upper three or four of which are broken into elongated pits by the feeble extensions of the axial ribs; aperture oval, outer lip thin, columella nearly straight, reflected, body of the shell without callus. The type measures: length, 4.9 mm.; maximum diameter, 1.2 mm.

Holotype, No. 9481, and paratypes, Nos. 9482, 9483 (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Loc. 23805 (C. A. S.), Puerto Escondido on the Lower California coast of the Gulf of California; collected by Dr. Fred Baker, in 1921.

This species belongs in the same group with *Turbonilla* (*Pyrgiscus*) *aripana* described in the present paper. It is smaller, with the whorls higher between the sutures, the ribs more numerous and the basal sculpture quite distinct.

The specific name of this species is derived from the tribal name of the Cochimi Indians, Lower California.

23. TURBONILLA (Pyrgiscus) pericuana Strong, new species
Plate 11, Figure 4

Shell elongate-conic, very slender, pale yellowish with a narrow, faint, brown band a little above the periphery on the last two whorls; nucleus a flattened coil with the apex slightly projecting, the maximum diameter nearly as great as that of the first postnuclear whorl on which it rests with the axis at nearly a right

[13] U. S. Nat. Mus., Bull. 68, December 13, 1909, p. 99, pl. 9, figs. 6, 6a.

angle to that of the succeeding whorls; postnuclear whorls eleven, rounded, more or less flattened in the middle, slowly but regularly increasing in size; axial sculpture of retractive, well developed ribs which pass over the periphery and reach nearly to the umbilical region, of these ribs fourteen appear on the first whorl, increasing to twenty on the last; intercostal spaces shallow, about twice as wide as the ribs; spiral sculpture of eight rows of incised lines in the interspaces, the lower line a little the strongest, the others nearly equal in strength and spacing; periphery rounded, marked by a narrow smooth band; base short, rounded, marked by five incised spiral lines which cut the feeble extensions of the axial ribs; aperture subquadrate, outer lip thin, columella nearly straight, reflected, body of the shell without a callus. The type measures: length, 6.0 mm.; maximum diameter, 1.3 mm.

Holotype, No. 9484, and paratypes, Nos. 9485, 9486 (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Loc. 23808 (C. A. S.), Concepcion Bay on the coast of Lower California in the Gulf of California; collected by Dr. Fred Baker, in 1921. Nine additional specimens were collected in the same locality.

This species is similar in size and shape to *Turbonilla* (*Pyrgiscus*) *histias* Dall & Bartsch[14] but has the axial ribs less well developed on the base and different spiral sculpture. Some of the paratypes show intercalary incised spiral lines in the interspaces and a greater flattening of the whorls but agree in all other ways. The extreme slenderness of the upper part of the spire is a striking character.

The specific name of this species is derived from the tribal name of the Pericù Indians, Lower California.

24. TURBONILLA (Mormula) coyotensis Baker, Hanna & Strong

Turbonilla (*Mormula*) *coyotensis* Baker, Hanna & Strong, Proc. Calif. Acad. Sci., ser. 4, vol. 17, No. 7, June 29, 1928, pp. 223-224, pl. 11, fig. 17.

In the original description of this species 2 specimens are recorded from Concepcion Bay and one specimen from San Luis Gonzaga Bay. To these there are added two specimens from Concepcion Bay and one from San Luis Gonzaga Bay. The latter specimen has many, fine, incised spiral lines instead of the 8 to 10 more distinct lines on the type.

25. TURBONILLA (Bartschella) cf. sedillina Dall & Bartsch

Turbonilla (*Dunkeria*) *sedillina* Dall & Bartsch, U. S. Nat. Mus.,

[14] U. S. Nat. Mus., Bull. No. 68, December 13, 1909, pp. 105-106, pl. 10, figs. 8, 8a.

Bull. No. 68, December 13, 1909, p. 121, pl. 12, fig. 3, 3a.

One specimen each from San Francisquito Bay and Puerto Escondido and three specimens from San Luis Gonzaga Bay are provisionally referred to this species. In the original description specimens are reported from La Paz and off Ceralvo Island. In our specimens there are fewer spiral cords and the angle at the shoulder is sharper than that shown in the figure of the type.

26. TURBONILLA (Bartschella) subangulata (Carpenter)

Dunkeria subangulata Carpenter, Cat. Mazatlan Shells, December, 1856, p. 424.

Turbonilla (Dunkeria) subangulata Carpenter, Dall & Bartsch, U. S. Nat. Mus., Bull. No. 68, 1909, p. 124, pl. 12, fig. 11.

Turbonilla (Bartschella) subangulata (Carpenter), Baker, Hanna & Strong, Proc. Calif. Acad. Sci., ser. 4, vol. 17, No. 7, 1928, p. 225, pl. 11, fig. 19.

Turbonilla subangulata Carpenter, Lowe, Trans. San Diego Soc. Nat. Hist., vol. 8, No. 6, 1935, p. 31.

Carpenter records the type locality of this species as "Mazatlan; extremely rare, off Spondylus," and mentions four specimens found by Mr. Hanley. Dall & Bartsch redescribe the Carpenter specimens. In our previous paper one specimen was recorded from Concepcion Bay and three from La Paz. Lowe records three specimens dredged at Punta Penasco. To these records can be added additional specimens from Concepcion Bay and La Paz and from the Gulf of California without definite locality.

27. PERISTICHIA hermosa Lowe

Pyramidellidæ (Triptychus) hermosa Lowe, Trans. San Diego Soc. Nat. Hist., vol. 8, No. 6, March 21, 1935, p. 22, pl. 3, fig. 4.

Lowe described this species from San Felipe, near the head of the Gulf of California. It is represented in the Academy's collection by 11 specimens taken in Concepcion Bay on the Gulf coast of Lower California. This species and "*Odostomia (Ividella)*" *pedroana* Dall & Bartsch[15] from southern California, are entirely distinct from anything else from the west coast and appear to be referable to the genus *Peristichia* Dall. Rehder (Proc. U. S. Nat. Mus., Vol. 93, No. 3161, p. 195, January 20, 1943) discussed this genus and stated "It differs from *Triptychus* in having only one basal entrant spiral cord, instead of two, and in lacking columellar folds." Lowe compared his species to *Pyramidella (Triptychus)*

[15] U. S. Nat. Mus., Bull. No. 68, December, 1909, p. 172, pl. 19, figs. 8, 8a.

olssoni Bartsch[16] which was described from Santa Elena Bay, Ecuador. Judging from the features said to characteristic of *Peristichia* it appears that Bartsch's species should remain in *Triptychus* Mörch.

28. ODOSTOMIA (Salassia) gabrielensis Baker, Hanna & Strong

Odostomia (*Salassia*) *gabrielensis* Baker, Hanna & Strong, Proc. Calif. Acad. Sci., ser. 4, vol. 17, No. 7, 1928, pp. 227-228, pl. 12, fig. 6.—Lowe, Trans. San Diego Soc. Nat. Hist., vol. 8, No. 6, 1835, p. 31.

In the previous paper specimens were reported from Espiritu Santo Island, Monserrate Island, San Jose Island and La Paz. Lowe reports 3 specimens from Punta Penasco. In the additional Academy material there are numerous specimens from San Jose Island, Concepcion Bay, La Paz and San Francisquito Bay, Gulf of California.

29. ODOSTOMIA (Besla) convexa (Carpenter)

Chrysallida convexa Carpenter, Cat. Mazatlan Shells, December, 1856, p. 424.

Odostomia (*Besla*) *convexa* (Carpenter), Dall & Bartsch, U. S. Nat. Mus., Bull. No. 68, 1909, p. 135, pl. 13, fig. 4.—Baker, Hanna & Strong, Proc. Calif. Acad. Sci., ser. 4, vol. 17, No. 7, 1928, p. 228.—Lowe, Trans. San Diego Soc. Nat. Hist., vol. 8, No. 6, 1935, p. 31.

Carpenter described this species from two specimens off Spondylus, at Mazatlan. Dall and Bartsch record two specimens dredged in 26 fathoms off Cacachitas, Gulf of California. In our previous paper one specimen from San Luis Gonzaga Bay is recorded. Lowe records 6 specimens dredged off Punta Penasco. To these records is now added one specimen from Concepcion Bay, one from Puerto Escondido and a number from the Gulf of California without definite locality.

30. ODOSTOMIA (Chrysallida) ovata (Carpenter)

Chrysallida ovata Carpenter, Cal. Mazatlan Shells, December, 1856, p. 417.

Odostomia (*Chrysallida*) *ovata* (Carpenter), Dall & Bartsch, U. S. Nat. Mus., Bull. No. 68, 1909, p. 152, pl. 15, figs. 7, 7a.—Baker, Hanna & Strong, Proc. Calif. Acad. Sci., ser. 4, vol. 17, No. 7, 1928, p. 232.

[16]Proc. U. S. Nat. Mus., Vol. 69, No. 2646, Art. 20, December 16, 1926, pp. 2-3, pl. 1, fig. 11.

Carpenter describes this species as from "Mazatlan; very rare, off Spondylus." Dall & Bartsch redescribe Carpenter's type and copy his camera lucida drawing. In our previous paper several specimens are recorded from Cape San Lucas. To this can be added one specimen from Concepcion Bay.

31. ODOSTOMIA (Chrysallida) telescopia (Carpenter)
Plate 11, Figure 3

Chrysallida telescopium Carpenter, Cat. Mazatlan Shells, December, 1856, pp. 421-422.

Odostomia (*Chrysallida*) *telescopium* Carpenter, Dall & Bartsch, U. S. Nat. Mus., Bull. No. 68, 1909, pp. 139-140, pl. 13, fig. 9. —Lowe, Trans. San Diego, Soc. Nat. Hist., vol. 8, No. 6, 1935, p. 31.

Carpenter records ten specimens (mostly young) off *Chama* and *Spondylus* at Mazatlan. Dall & Bartsch redescribe Carpenter's type and copy his camera lucida figure. Lowe reports the species as dredged off Punta Penasco. In the additional material in the Academy's collection there are numerous specimens from Concepcion Bay and La Paz. The species seems to be quite common in the upper end of the Gulf as it has been collected in considerable numbers by various collectors at San Felipe. Adult specimens of eight whorls reach a length of 5 mm., the additional whorls giving the shell a more slender appearance than that shown by the figure.

32. ODOSTOMIA (Chrysallida) torrita Dall & Bartsch

Odostomia (*Chrysallida*) *torrita* Dall & Bartsch, U. S. Nat. Mus., Bull. No. 68, December 13, 1909, p. 142, pl. 14, fig. 2.

The type of this species is one of four specimens available to Dall and Bartsch out of no fewer than five hundred specimens reported by Carpenter[17] to have been "abundant among algæ on *Uvanilla*, somewhat rare on *Chama*, *Spondylus*, etc.," at Mazatlan. Carpenter described the species in detail but considered it to be the same as *Chemnitzia cummunis* C. B. Adams[18] from Panama. To the original record of this very small species there is here added 2 specimens from San Francisquito Bay and 3 from the Gulf of California without definite locality.

33. ODOSTOMIA (Chrysallida) vizcainoana Baker, Hanna & Strong

Odostomia (*Chrysallida*) *vizcainoana* Baker, Hanna & Strong,

[17] Carpenter, P. P., Cat. Mazatlan Shells, November, 1856, pp. 419-420.
[18] C. B. Adams, Ann. Lyceum Nat. Hist. New York, Vol. 5, July, 1852, pp. 390, 536 (separate, pp. 166, 312).

Proc. Calif. Acad. Sci., ser. 4, vol. 17, No. 7, June 29, 1928, pp. 229-230, pl. 12, fig. 10.

In the original description specimens of this species are recorded from off La Paz, Puerto Escondido, Agua Verde Bay and San Jose Island. To these is now added six specimens from Concepcion Bay.

34. ODOSTOMIA (Chrysallida) sorenseni Strong, new species
Plate 11, Figure 2

Shell elongate-ovate, small, yellowish-white; nuclear whorls small, deeply immersed in the first postnuclear whorl above which only the tilted edge appears; postnuclear whorls six, flattened, separated by a deep, channeled suture; axial sculpture or narrow, retractive ribs with wider interspaces, of which 16 appear on the first postnuclear whorl, increasing to 22 on the penultimate whorl; spiral sculpture of narrow threads, at no place as strong as the axial ribs; on the first two whorls one spiral cord appears at the summit and a second at the edge of the suture, beginning with the third whorl intermediate threads begin to appear and increase in number and strength until on the penultimate whorl there are six subequal cords; the intersections of the axial ribs and spiral cords from rounded nodules while the interspaces appear as rectangular pits; periphery of last whorl marked by a deep groove; base somewhat produced, marked by six spiral cords and continuations of the axial sculpture as very fine threads; aperture ovate, outer lip thin in the central portion, thickened at the posterior angle; columella stout, reflected anteriorly, with a weak fold at its insertion. The type measures: length, 2.2 mm.; maximum diameter, 1.0 mm.

Holotype, No. 9488, and paratypes, Nos. 9489, 9490 (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Loc. 27223 (C. A. S.), Mazatlan, Mexico. The type and 13 additional specimens were collected by L. G. Hertlein.

This species appears to be quite distinct from anything previously described from the west coast. In the key to the subgenus[19] by Dall & Bartsch it would follow *reigeni* Carpenter[20] in the Gulf fauna, differing in the retractive axial ribs, nodulous sculpture and in other ways.

This species is named for Mr. Andrew Sorensen of Pacific Grove, California, who on several occasions, has collected mollusks in the Gulf of California.

[19] U. S. Nat. Mus., Bull. No. 68, 1909, p. 137.
[20] *Chrysallida reigeni* Carpenter, Cat. Mazatlan Shells, December, 1856, p. 422.—Dall & Bartsch, U. S. Nat. Mus., Bull. No. 68, 1909, pp. 138-139, pl. 13, fig. 7.

35. Odostomia (Pyrgulina) herreræ Baker, Hanna & Strong

Odostomia (Pyrgulina) herreræ Baker, Hanna & Strong, Proc. Calif. Acad. Sci., ser. 4, vol. 17, No. 7, June 29, 1928, pp. 233, 234, pl. 12, fig. 9.

The type of this species is reported to have been collected in the Gulf of California. There is now recorded definite localities of two specimens from San Francisquito Bay and two from La Paz.

36. Odostomia (Ividella) ulloana Strong, new species
Plate 11, Figure 1

Shell small, translucent white, elongate-ovate; nuclear whorls deeply, obliquely immersed in the first postnuclear whorl; postnuclear whorls five, flattened, strongly, almost tabulately shouldered, separated by a deep suture; axial sculpture of strong, curved ribs which extend over the shoulder to the suture and over the base to the umbilical region, of these 12 appear on the first whorl, increasing to 20 on the penultimate whorl; spiral sculpture of four cords, the first, rather indistinct, marking the shoulder of the whorl; the second, much stronger, a little below the middle of the whorl; the third at the periphery of the body whorl; and the fourth on the middle of the base; intersections of the axial ribs and spiral cords slightly pointed; entire surface marked with microscopic spiral striæ and lines of growth; aperture ovate, outer lip thin, slightly angulated by the spiral cords; columella slender, curved, raised above a narrow umbilical groove, with an obscure fold at its insertion. The type measures: length, 2.5 mm.; maximum diameter, 1.0 mm.

Holotype, No. 9491 (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from Loc. 23806 (C. A. S.), La Paz, Lower California; collected by Dr. Fred Baker in 1921.

This is the fifth species to be described in a very closely related group constituting the subgenus *Ividella*. The various species range from Monterey, California, to Panama and differ principally in the number of spiral cords. The present species, with but four cords, has the smallest number for any of them.

This species is named for Francisco de Ulloa, Admiral of Cortez, who in 1540 arrived at the headwaters of the Gulf of California.

37. Odostomia (Miralda) æpynota Dall & Bartsch

Odostomia (Miralda) æpynota Dall & Bartsch, U. S. Nat. Mus., Bull. No. 68, December 13, 1909, p. 178, pl. 19, fig. 5.

In the original description one specimen of this California species was recorded from Cape San Lucas. There is now recorded two specimens from Concepcion Bay which seem to belong to the typical form.

38. ODOSTOMIA (Miralda) æpynota planicostata Baker, Hanna & Strong

Odostomia (*Miralda*) *æpynota planicostata* Baker, Hanna & Strong, Proc. Calif. Acad. Sci., ser. 4, vol. 17, No. 7, June 29, 1928, p. 237, pl. 12, fig. 14.

This variety was based on four specimens from Cape San Lucas. An additional specimen from San Francisquito Bay seems to belong here.

39. ODOSTOMIA (Menestho) ciguatanis Strong, new species
Plate 12, Figure 3

Shell elongate-conic, milk white; nuclear whorls very small, having an elevated spire with the axis at right angles to that of the succeeding whorls in the first of which they are about one-third immersed; postnuclear whorls six, flattened, regularly increasing in size, sculptured with three strong, equal cords with deep, grooved interspaces, equal in depth and only slightly narrower than the channel suture; periphery angulated, marked by a spiral cord a little less strong than those on the spire; base short, with three spiral cords of which the upper, separated from the peripheral cord by a narrow groove, is much the strongest; aperture ovate, effuse anteriorly, outer lip thin, somewhat angulated by the spiral cords; columella curved, separated from the base by an indistinct umbilical groove, with a strong fold at its insertion. The type measures: length, 3.0 mm.; maximum diameter, 1.4 mm.

Holotype, No. 9492, and paratypes, Nos. 9493, 9494 (Calif. Acad. Sci. Dept. Paleo. Type Coll.), from the Gulf of California without definite location; collected by Dr. Fred Baker in 1921. The collection contained nine additional specimens.

This species is very similar in appearance to *Odostomia* (*Menestho*) *grammatospira* Dall & Bartsch[21] from Cape San Lucas, but has three spiral cords instead of four and a more angulated periphery and shorter base. All the specimens are bleached, the living shells are probably a translucent white.

The specific name of this species is derived from that of a pearl island Ciguatan, sought by Ulloa in the Gulf of California.

[21]Mem. Calif. Acad. Sci., Vol. 3, 1903, p. 285, pl. 1, figs. 6, 6a.—U. S. Nat. Mus., Bull. No. 68, 1909, p. 185, pl. 21, figs. 7, 7a.

40. ODOSTOMIA (*Evalea*) tenuis (Carpenter)

Odostomia tenuis Carpenter, Cat. Mazatlan Shells, November, 1856, p. 412.

Odostomia (*Evalea*) *tenuis* Carpenter, Dall & Bartsch, U. S. Nat. Mus., Bull. No. 68, 1909, pp. 197-198, pl. 22, fig. 3.

Carpenter's description is from two specimens off *Spondylus* at Mazatlan. Dall and Bartsch redescribe the species and copy Carpenter's camera lucida drawing. In the Academy's material there are three specimens from Concepcion Bay which seem to agree with the description and figure.

Plate 11

Fig. 1. *Odostomia* (*Ividella*) *ulloana* Strong, nsp. Holotype, from La Paz, Lower California. Length, 2.5 mm.; maximum diameter, 1.0 mm.

Fig. 2. *Odostomia* (*Chrysallida*) *sorenseni* Strong, nsp. Holotype, from Mazatlan, Mexico. Length, 2.2 mm.; maximum diameter, 1.0 mm.

Fig. 3. *Odostomia* (*Chrysallida*) *telescopia* Carpenter. Hypotype, from Loc. 23806 (C. A. S.), La Paz, Lower California, Mexico. Length, 4.1 mm.; maximum diameter, 1.3 mm.

Fig. 4. *Turbonilla* (*Pyrgiscus*) *pericuana* Strong, nsp. Holotype, from Concepcion Bay, east coast of Lower California, Mexico. Length, 6.0 mm.; maximum diameter, 1.3 mm.

Fig. 5. *Turbonilla* (*Pyrgiscus*) *aripana* Strong, nsp. Holotype, from Puerto Escondido, east coast of Lower California, Mexico. Length, 6.0 mm.; maximum diameter, 1.7 mm.

Fig. 6. *Turbonilla* (*Pyrgiscus*) *kaliwana* Strong, nsp. Holotype from San Luis Gonzanga Bay, east coast of Lower California, Mexico. Length, 6.0 mm.; maximum diameter, 1.2 mm.

All the specimens illustrated on this plate are in the type collection of the department of Paleontology of the California Academy of Sciences. The photographs used in illustrating the species were made by Frank Lee Rogers.

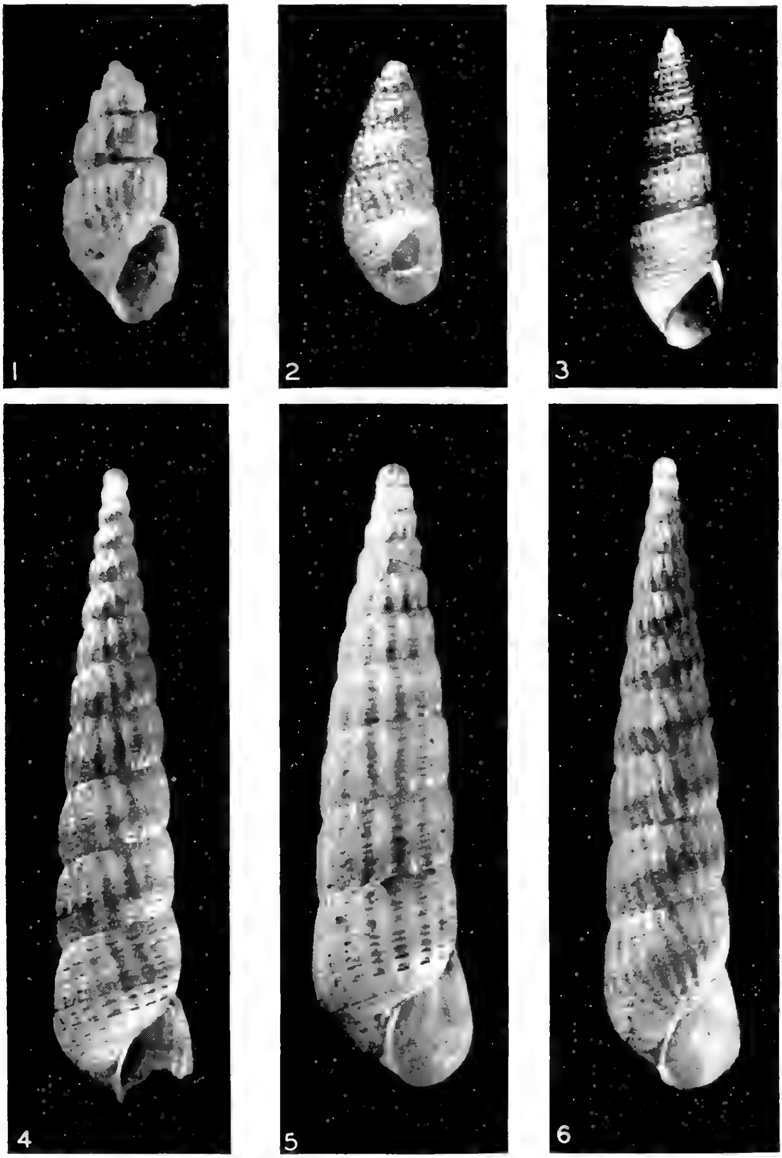

PLATE 11

Plate 12

Fig. 1. *Turbonilla (Pyrgiscus) guaicurana* Strong, nsp. Holotype, from La Paz, east coast of Lower California, Mexico. Length, 3.2 mm.; maximum diameter, 1.3 mm.

Fig. 2. *Turbonilla (Chemnitzia) sinaloana* Strong, nsp. Holotype, from Mazatlan, Mexico. Length, 2.9 mm.; maximum diameter, 0.8 mm.

Fig. 3. *Odostomia (Menestho) siguatanis* Strong, nsp. Holotype, from the Gulf of California, exact locality unknown. Length, 3.0 mm.; maximum diameter, 1.4 mm.

Fig. 4. *Turbonilla (Pyrgiscus) cochimiana* Strong, nsp. Holotype, from Puerto Escondido, east coast of Lower California, Mexico. Length, 4.9 mm.; maximum diameter, 1.2 mm.

Fig. 5. *Turbonilla (Pyrgiscus) alarconi* Strong, nsp. Holotype, from Concepcion Bay, east coast of Lower California, Mexico. Length, 4.5 mm.; maximum diameter, 1.6 mm.

Fig. 6. *Turbonilla (Strioturbonilla) asuncionis* Strong, nsp. Holotype, from Asuncion Island, off the west coast of Lower California, Mexico. Length, 3.4 mm.; maximum diameter, 1.0 mm.

All the specimens illustrated on this plate are in the type collection of the department of Paleontology of the California Academy of Sciences. The photographs used in illustrating the species were made by Frank Lee Rogers.

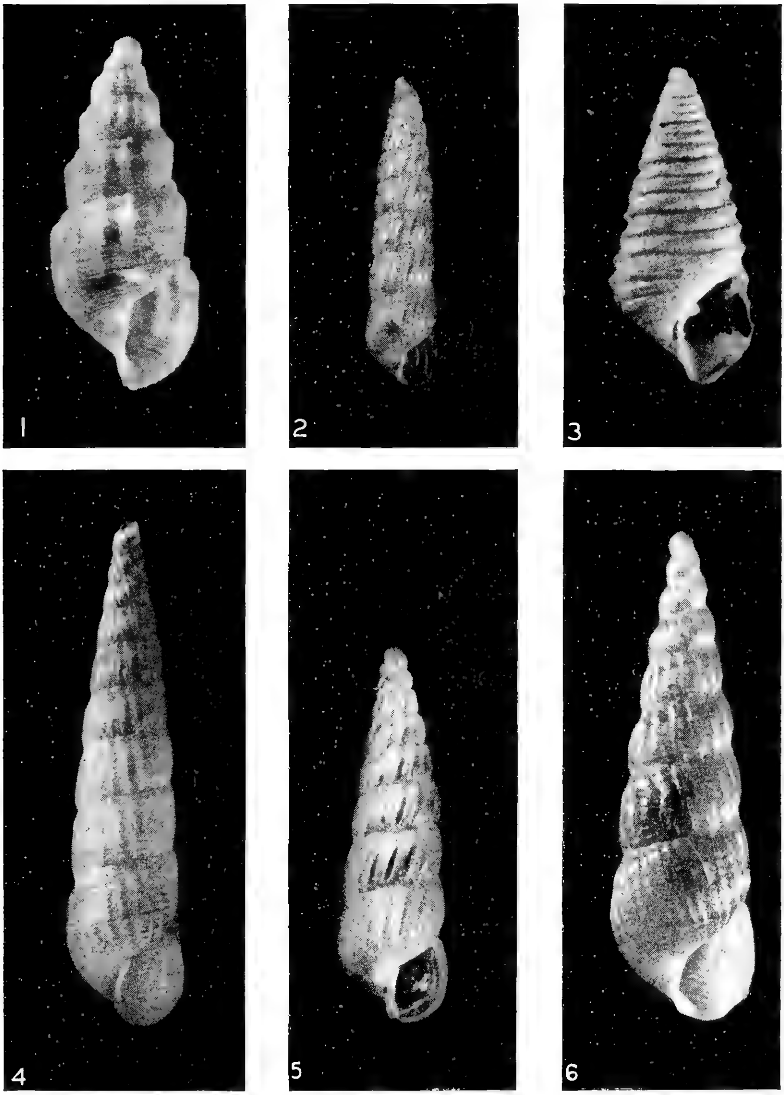

PLATE 12

DR. ROBERT DUDLEY EMERY

September 6, 1877—March 20, 1949

The death of Dr. Robert Dudley Emery on March 20, 1949 marks the passing of one of the pioneers in the development of the Southern California Academy of Sciences.

Dr. Emery was born in Montpelier, Vermont, September 6, 1877.

He married Lora Bell Haney in St. Catherine, Missouri, April 27, 1900. A son by this marriage, Clyde K. Emery, M. D., survives him.

His second marriage to Beatrice E. Hutchinson occurred in Alhambra, California on January 6, 1932.

Robert D. Emery held three doctorate degrees. He received his D.O. in 1899, and was granted his M.D. in 1908. Five years

prior to his death he was awarded an honorary Doctorate in Science.

He was admitted to the practice of medicine and surgery in Massachusetts in 1904, but five years prior to that had begun private practice in Hawaii. He specialized first in surgery and later in radiology.

Dr. Emery was a student throughout all of his useful and very active life. He made frequent trips to the European Clinics, and the larger eastern Clinics of the United States, and had post-graduate work in the New York Post-graduate Medical School and Hospital; the West London Post-graduate Medical School and Hospital; Queen Charlotte's Lying-in Hospital, and the Allgemeines Krankenhaus of Vienna.

He served a term as President of the California Osteopathic Association, and as Vice-president of the American Osteopathic Association, and he also held the Presidency of the California Board of Osteopathic Examiners. In addition he filled positions of trust and responsibility in a number of professional organizations.

Dr. Emery was a Fellow of the Southern California Academy of Sciences and at the time of his death was a member of its Board of Trustees and Chairman of its Section of Health and Sanitation. He was respected for his scholarly attainments, and beloved for his willingness to give of himself and his substance in the interests of mankind.

J. A. C.

IN MEMORIAM: CATHERINE VIRGINIA BEERS

JUNE 3, 1892—APRIL 22, 1949

The death of Dr. Catherine Beers, after a brief illness in the Queen of Angels Hospital, was a shock to her many friends in the Southern California Academy of Sciences where she had been a member since May 2, 1941.

Dr. Beers was an associate professor of zoology at the University of Southern California where she had been a member of the faculty for 33 years. She not only taught day classes, but also University College (night) classes in heredity and zoology. Many doctors and biology teachers did undergraduate work in her classes. Her enriched life of activity and enviable achievements on the frontiers of science included forethought, by decreeing in writing that an autopsy be performed immediately following death, the results to be used to augment the fight against cancer, the cause of her death.

Internationally known as a geneticist, Dr. Beers had many interests: people, students, faculty, teaching, scholarship, research, fundamental genetics, medical genetics, and cancer.

Miss Beers began life in a mid-western community, Chicago, Illinois. She received her Bachelor of Arts and Master of Arts degrees from Northwestern University in 1914 and 1915 respectively, and her Doctor of Philosophy from Columbia in 1938. Her studies in marine life were attained at the Oceanographic Laboratories of the University of Washington, the University of California at La Jolla, and on the east coast at Woods Hole, Mass. She taught at Hunter College, N. Y. and at Washington Square College of the same state.

Professional organizations were favored by her presence and her contributions to science. She was a member of the Amer. Assoc. for Advancement of Science; the Soc. of Sigma Xi; Phi Kappa Phi, President, 1947-48; Genetics Soc. of Amer.; Western Soc. of Naturalists; Univ. of Southern California Faculty Science Club, President; served as Sec. of the Local Chap. of the Amer. Assoc. of Univ. Professors; founder-member of Phi Sigma, Nat. Honorary Biol. Soc.; Faculty Adviser for Omega Delta, University College Soc.; Amer. Assoc. of University Women; Phi Lambda Theta, Education Honorary Soc.; Genetics Soc. of Amer.; Eugenics Soc.; Science Teachers of Amer.; Honorary member of Mortar Board Phrateres; and other organizations.

Last year she was honored as the first woman to give the science research lecture at the annual dinner of the Graduate School of Research at the University of Southern California.

The experimental work of Dr. Beers is based on her study of 200 generations of the fruit fly, and the results together with methods, are correlated with problems of the human species.

Eminence abroad is attested by her invitation paper presented, 1939, before the International Congress of Geneticists in Edinburgh, Scotland, and again last year under the same auspices in the presence of 600 famous scientists from 38 nations at Stockholm, Sweden. Following the latter meeting she made a world tour by airplane.

Dr. Beers emphasized basic problems in heredity and medical genetics among her contributions to science. One of her early papers (1937), "Linkage Groups in *Drosophila pseudoobscura,* Race B," published in the Jour. of Genetics 22, was followed by "Mutants of *Drosophila pseudoobscura,* Race B," presented as a demonstration at the autumn, 1939, meeting of the Genetics Soc. at Woods Hole, Mass. Another paper, "Human Genetics," was given at the 1940 meeting of the Hollywood Acad. of Med., while "Inherited Hollow-chest" was presented at the Monterey 1939

meeting of the Western Soc. of Nat. A joint-authorship paper with Lathan Clark, "A Hemangioma and Metatarsus Atavicus," was published in the Jour. of Heredity 33. Another joint paper with Estel A. Cheever on "Hereditary Ataxia," appeared in the Jour. of Heredity 36. "Four Generations of Heart Trouble" was presented at the June 1947 meeting of the Western Soc. of Naturalists, and, "Four Generations of Rheumatic Heart Disease" was presented at the 1948 meeting of the International Congress of Genetics at Stockholm, Sweden. During the same year another paper, "Human Genetics," was given at the Chundikuli Girls' College, Jaffna, Ceylon.

Friends of Dr. Beers have been inspired to establish a Dr. Catherine V. Beers Memorial Fund to provide money for research at the University of Southern California.

Dr. Beers also taught classes in ornithology, wrote poetry and would laugh at words like these:

Ever cheerful with a sense of humor
Undaunted by embolism or a tumor
Ever jovial to meet a friend
Courageous, she was fearless to the end.

GEORGE R. JOHNSTONE

The SOUTHERN CALIFORNIA ACADEMY OF SCIENCES

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By

E. A. McGregor

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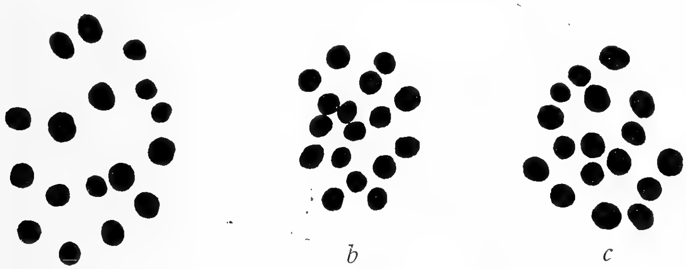
VOLUME 48 - - - - - - - PART 3, 1949

DUDLEYA STOLONIFERA, A NEW SPECIES FROM ORANGE COUNTY, CALIFORNIA

By REID MORAN

This new species of *Dudleya* occurs near Laguna Beach, California, in two canyons of the San Joaquin Hills. It is of particular interest because it seems intermediate in some respects between the subgenera Eududleya and Stylophyllum. Also described is a putative natural hybrid between the new species and *D. edulis* (Nutt.) Moran, a member of the subgenus Stylophyllum.

Chromosome counts of the two plants were made by Dr. Charles H. Uhl of Cornell University. He has kindly consented to the inclusion here of his previously unpublished data.



a *b* *c*

PLATE 13

Figs. *a-c*. Chromosomes of *Dudleya* at first meiotic metaphase, X3900. Camera lucida drawings by Dr. Charles H. Uhl. Fig. *a*, *D. edulis*, hills south of Tijuana, Baja California, *Moran 2103*. Fig. *b*, *D. edulis* X *stolonifera*, Aliso Canyon, Orange County, California, *Moran 3097*. Fig. *c*, *D. edulis* X *stolonifera*, approaching *D. edulis*, Aliso Canyon, *Moran 3257*.

DUDLEYA STOLONIFERA Moran, species nova.

Caudex diametro 1½-3 cm., usque 10 cm. longus, ramos laterales horizontales diametro 3-8 mm. et mox 5 cm. longos in axillis foliorum infimorum edens. Rosula sæpe subplana, diametro 5-12 cm., foliis 15-25 constans. Folia rosulata oblongo-obovata, breviter acuminata, 3-7 cm. longa, 1½-3 cm. lata, 3-4 mm. crassa, viridia sed sæpe præcipue dorsaliter aliquid purpurascentia, non glauca, supra plana vel concava, subtus convexa, marginibus subacuta, basi 10-20 mm. lata, circa 1 mm. alta incrassata. Caules

floriferi in axillis foliorum inferiorum, 8-20 (—25) cm. alti, diametro 2-4 mm., supra basim 3-6 cm. tantum nudi. Folia caulina horizontales, cordato-ovata, acuta, eis infimis 8-13 mm. longis, 5-7 mm. latis. Inflorescentia plerumque duobus interdum pluribus cincinnis ascendentibus constans. Cincinni 1-6 cm. longi, 3-9 flores ferentes. Pedicelli erecti, eis inferioribus 5-8 mm., eis superioribus 3-5 mm. longis. Calyx 5½-7 mm. latus, 3-4 mm. altus, basi usitate truncatus; segmentis triangularibus, crassis, 2-3 mm. longis, 2½-4 mm. latis. Petala lutea, elliptica, acuta, erecta, inter se contingentia, apice tantum leviter excurvata, 10-11 mm. longa, 3-3½ mm. lata, basi 1-2 mm. connata. Stamina 5½-6½ mm. longa, ad basim corollæ 1½-2 mm. adnata, eis antesepalis sensim longioribus. Antheræ luteæ, circa 1½ mm. longæ. Carpella suberecta, sensim separata, supra basim dilatata, inde fastigata, infra stylum circa 1 mm. longum 4-6 mm. alta; eis maturis ascendentibus, apicibus 2-3 mm. separatis. Squamæ albæ, ½-1 mm. lata.

PLATE 14
Dudleya stolonifera Moran

Caudex 1½-3 cm. thick, becoming 10 cm. or more long. Horizontal branches from the axils of the lower rosette leaves, 3-8 mm. thick, soon becoming 5 cm. long. Rosette often rather flat, 5-12 cm. in diameter, with about 15-25 leaves. Rosette leaves oblong-obovate, short acuminate, 3-7 cm. long, 1½-3 cm. broad, 3-4 mm. thick, bright green, not at all glaucous, often becoming maroon especially dorsally and towards apex, plane or concave above, convex below; the margins subacute; the base 10-20 mm. wide, ca 1 mm. high. Floral stem 8-20 (—25) cm. high, 2-4 mm. thick, leafy

to within 3-6 cm. of the base. Cauline leaves horizontal, cordate-ovate, acute, the lowermost 8-13 mm. long, 5-7 mm. broad. Inflorescence commonly of two simple ascending cincinni, occasionally of three or more branches which may bifurcate. Cincinni 1-6 cm. long, with 3-9 flowers. Pedicels erect, the lower 5-8 mm. long, the upper 3-5 mm. long. Calyx 5½-7 mm. broad, 3-4 mm. high, usually truncate below; the segments deltoid, thick, 2-3 mm. long, 2½-4 mm. broad. Petals bright yellow, elliptic, acute, erect, appressed with only the tips outcurved, 10-11 mm. long, 3-3½ mm. broad, connate 1-2 mm. Antesepalous stamens 6-6½ mm. long, adnate 1½-2 mm; epipetalous stamens 5½-6 mm. long, adnate 1½-2 mm. Anthers yellow, ca 1½ mm. long. Carpels at anthesis nearly erect, but separated, broadened above the base, then tapering, 5-7 mm. high including styles 1-1½ mm. long; predehiscent mature carpels ascending, with tips ca 2-3 mm. apart. Scales white, ½-1 mm. broad. Chromosome number: $n = 17$.

TYPE COLLECTION: North-facing cliff near the mouth of Aliso Canyon, San Joaquin Hills, Orange County, California, June 23, 1948, *Moran 3095*. Type specimen in the herbarium of the University of California at Berkeley.

DISTRIBUTION: Locally abundant on north-facing cliffs at 10 to 250 meters in Aliso and Laguna Canyons. Represented in the Pomona College Herbarium by *F. M. Reed 4994* collected in Aliso Canyon in 1925.

This is the only species of *Dudleya* known to be stoloniferous; other species branch only dichotomously unless the terminal bud is injured. This species is also remarkable for the broad low calyx and the combination of erect petals and spreading predehiscent carpels.

DUDLEYA EDULIS × STOLONIFERA Moran, hybrida nova.

Caudex diametro 2-2½ cm., dichotome ramosus, igitur cæspites parvos formans. Rosula diametro 6-12 cm., foliis ascendentibus circa 25-30 constans. Folia rosulata linguiformia, ad medium leviter dilatata, subapiculata, 5-11 cm. longa, 9-15 mm. lata, 3-4 mm. crassa, non glauca, supra plana, subtus convexa, marginibus rotundata, basi 15-20 mm. lata, 1-2 mm. alta incrassata. Caules floriferi 18-30 cm. alti, diametro 3-5 mm., supra basim 5-10 cm. nudi. Folia caulina ascendentia, trianguli-ovata, acuta; eis infimis 10-25 mm. longis, 6-10 mm. latis. Inflorescentia circa tres ascendentibus ramis simplicibus vel bifurcatis constans. Cincinni subcircinati, 5-11 cm. longi, flores plerumque 7-13 ferentes. Pedicelli erecti, inferioribus 2-3 mm., superioribus 1-2 mm. longis. Calyx 5-7 mm. latus, 4-5 mm. altus, basi rotundatus vel truncatus; segmentis trianguli-ovatis, acutis, 3-4 mm. longis,

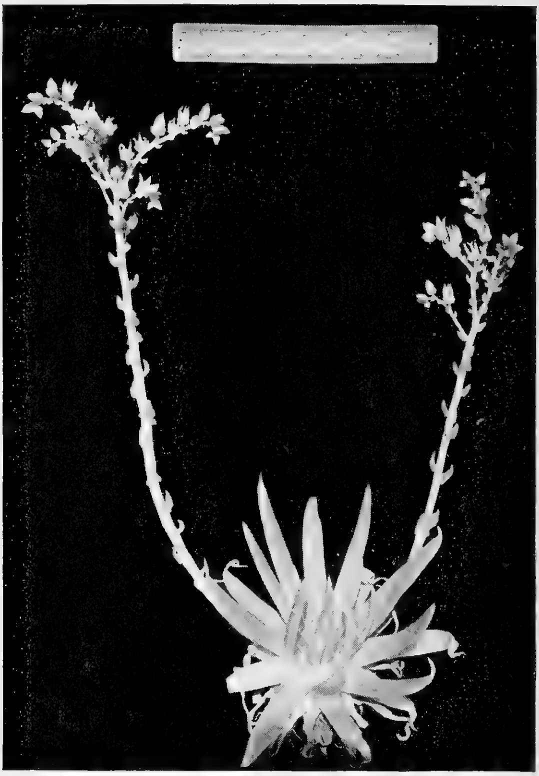


PLATE 15
Dudleya edulis x stolonifera

2½-4 mm. latis. Petala pallide lutea, elliptico-oblonga, acuta, 10-13 mm. longa, circa 3 mm. lata, ad basim versus erecta, 1½-2 mm. connata, supra excurvata, apice ascendentia vel expandentia. Stamina subæqualia, 6-8½ mm. longa, eis epipetalis circa 2 mm. adnatis, eis antesepalis circa 1½ mm. adnatis. Antheræ aurantiæ, circa 1½ mm. longæ. Carpella primo suberecta, separata, infra stylum circa 2 mm. longum 4-6 mm. alta; eis maturis diametro circa 3 mm., ascendentibus, apicibus circa 5 mm. separatis. Squamæ albæ, ½-1 mm. latæ.

Caudex 2-2½ cm. thick, branching dichotomously to form small clumps. Rosette 6-12 cm. in diameter, with about 25-30 ascending leaves. Rosette leaves broadly linear, slightly broadened near the middle, subapiculate, 5-11 cm. long, 9-15 mm. broad, 3-4 mm. thick, not glaucous, plane above, convex below, with rounded margins; the base 15-20 mm. broad, 1-2 mm. high. Floral stems 18-30 cm. high, 3-5 mm. thick, leafless in lower 5-10

cm. Cauline leaves ascending, triangular-ovate, acute, the lower 10-25 mm. long, 6-10 mm. broad. Inflorescence of about three ascending simple or bifurcate branches. Cincinni subcircinate, 5-11 cm. long, with usually 7-13 flowers. Pedicels erect, the lower 2-3 mm. long, the upper 1-2 mm. long. Calyx 5-7 mm. broad, 4-5 mm. high, rounded to truncate below; the segments triangular-ovate, acute, 3-4 mm. long, 2½-4 mm. wide. Petals pale yellow, elliptic-oblong, acute, 10-13 mm. long, 3 mm. broad, erect below, gently curved outward so that the tips are ascending or spreading, connate 1½-2 mm. Stamens nearly equal, 6-8½ mm. long, the episepalous adnate ca 1½ mm., the epipetalous ca 2 mm. Anthers orange, ca 1½ mm. long. Carpels at first nearly erect but separated, 6-8 mm. high including styles ca 2 mm. long; predehiscent mature carpels ca 3 mm. thick, ascending, with tips ca 5 mm. apart. Scales white, ½-1 mm. broad. Chromosome number: $n=17$.

TYPE COLLECTION: With the type of *Dudleya stolonifera* from north-facing cliff near mouth of Aliso Canyon, June 23, 1948, *Moran 3097*. Type specimen in the herbarium of the University of California, Berkeley.

Since the cross has not been duplicated artificially, the hybrid origin of these plants cannot be considered proven. However, the circumstantial evidence from morphology and distribution seems so strong that there is little reason for doubt. Also, the cytological data are consistent with this interpretation.

The plant described in the text and in Table 1 as a hybrid is what may be called the primary hybrid type. In nearly all respects, this is morphologically intermediate between the two parent species. Perhaps especially striking are the relative width of the rosette leaves, the attitude of the petals, and the color of the petals and anthers. Presumably this type represents or approximates a first-generation hybrid.

Also present, but less abundant, are plants which may be called secondary hybrid types. These are intermediate between the primary hybrid type and one or the other parent species, as if by backcrossing. These do not show a random recombination of characters. Rather, each seems to depart from the primary hybrid type toward one of the parent species by about the same amount in each character.

Since the series of hybrids more or less connects the two parent species, a description embracing all the hybrids would practically amount to the combined descriptions of the two parent species. It has therefore seemed best to describe the primary hybrid type alone.

	DUDLEYA EDULIS	HYBRID	DUDLEYA STOLONIFERA
Branching of caudex	Dichotomous	Dichotomous	By stolons
Rosette leaves	Linear, not broadened above Acute to subacuminate Terete at least above 1-1½ times broader than thick (except at base) 8-20 cm. X 4-9 mm. X 3-6 mm.	Broadly linear, somewhat broadened above Acute to subacuminate Margins rounded 3-4 times broader than thick 5-11 cm. X 9-15 mm. X 3-4 mm.	Oblong-obovate Short acuminate Margins subacute 5-8 times broader than thick 3-7 cm. X 15-30 mm. X 3-4 mm.
Floral stems	25-40 cm. tall 4-10 mm. thick	18-30 cm. tall 3-5 mm. thick	8-25 cm. tall 2-4 mm. thick
Cauline leaves	Terete, strongly ascending 20-50 mm. long	Turgid, ascending 10-25 mm. long	Thin, horizontal 8-13 mm. long
Inflorescence	Usually of several branches which bifurcate once or twice	Usually of 3-4 branches which are simple or once bifurcate	Often of 2 simple cincinni; sometimes of 3-4 branches which may bifurcate
Lower pedicels	1-2 mm. long	2-3 mm. long	5-8 mm. long
Sepals	Oblong ovate 2½-4½ mm. long, 2-2½ mm. wide	Triangular ovate 3-4 mm. long, 2½-4 mm. wide	Triangular 2-3 mm. long, 2½-4 mm. wide
Petals	White Erect below, widespreading or reflexed from middle	Pale yellow Erect below, ascending or spreading from middle	Bright yellow Erect, forming tube, with only tips outcurved
Anthers	Red	Orange	Yellow
Chromosomes	$n=17$	$n=17$	$n=17$

TABLE 1

PLATE 16

DUDLEYA STOLONIFERA, robust plant and average plant

The hybrids have been found only where the two parent species grow together. In the mouth of Aliso Canyon, *Dudleya edulis* apparently reaches its northern limit. It is abundant on the higher north-facing slopes, and a few plants of it grow below on the cliffs with *D. stolonifera.* The hybrids are found on these same cliffs. Not more than a score of hybrids were seen, though both parent species are abundant close by. Further up Aliso Canyon and in Laguna Canyon, *D. edulis* apparently is absent from the cliffs where *D. stolonifera* grows. The hybrid also appears to be absent there.

For the type collection of *Dudleya stolonifera,* Dr. Uhl reports a haploid number of 17 chromosomes. Likewise, in a collection of *D. edulis* from the same locality and in eight collections from other localities throughout the range of the species, the haploid number is 17. The hybrid also has a haploid number of 17. The occurrence of the same haploid number in both putative parent species and in the putative hybrid is consistent with the hypothesis of hybridity.

In one collection of the primary hybrid type and in one collection of a secondary hybrid type, Dr. Uhl found no evidence of abnormality in meiosis. In another collection of a secondary hybrid type too old to show meiosis, he found some indication of slightly reduced fertility in the pollen. However, in various species he has found a similar condition in the last flowers of the season, even though the plants probably were quite normal. Since the parent species seem very different from each other morphologically, it is interesting that there should be no convincing evidence of meiotic irregularity. However, the comparative scarcity of hybrids may be an indication of reduced fertility.

THE POSITION OF DUDLEY STOLONIFERA

The plant here named *Dudleya stolonifera* was treated by Munz (1935) under *Echeveria cæspitosa* (Haw.) DC. The plants usually identified with this name form a difficult polyploid complex distributed along the coast from central California to Point Mugu, Ventura County. They do not closely resemble *D. stolonifera,* differing especially in their dichotomously branching and often elongating caudex, longer, narrower, and thicker leaves, taller and stouter floral stems, denser and more complex inflorescence, and erect predehiscent carpels.

In synonymy under *Echeveria cæspitosa*, Munz listed *Dudleya ovatifolia* Britt., of the Sierra Santa Monica. This plant is quite distinct from the *D. cæspitosa* complex: it appears to belong instead with the widespread polytypic diploid *D. cymosa* (Lem.) Britt. & Rose (*Echeveria laxa* of Jepson and other authors).

Dudleya ovatifolia also is quite distinct from *D. stolonifera*, as shown in Table 2. Despite the differences, however, there are

	DUDLEYA STOLONIFERA	DUDLEYA OVATIFOLIA
Caudex	Stoloniferous 1½-3 cm. in diameter Elongating to 10 cm. or more	Unbranched (so far as seen) 1-1½ cm. in diameter Rarely 3 cm. long
Rosette	5-12 cm. in diameter Containing 15-25 leaves	4-8 cm. in diameter Containing 6-10 leaves
Rosette leaves	Obovate to spatulate, acuminate, usually abruptly so 3-7 cm. long, 1½-3 cm. wide	Elliptic to ovate, acute to acuminate 3-5 cm. long, 1½-2½ cm. wide
Floral stems	8-25 cm. tall	4-13 cm. tall
Cauline leaves	Cordate, ovate	Cordate, ovate-lanceolate
Inflorescence		More compact
Calyx	5½-7 mm. broad, 3-4 mm. high Truncate below	3-4 mm. broad, 2½-3 mm. high Rounded below
Corolla	About 5 mm. in diameter	About 3 mm. in diameter
Petals	3-3½ mm. wide	2-2½ mm. wide
Carpels	Spreading before dehiscence	Not spreading before dehiscence

TABLE 2

many points of similarity. The rosette leaves may be of about the same size and shape; and they are similar in color, even to the maroon suffusion dorsally. The floral stems are short and slender, and their leaves are similar in number, size, shape, and attitude. The inflorescence in both is usually rather simple. The bright yellow petals are narrowly acute and slightly outcurved at the apex. These similarities add up to a strong general resemblance.

Other members of the *Dudleya cymosa* complex resemble *D. stolonifera* in other respects; but *D. ovatifolia* seems to bear it

the closest resemblance. It is difficult to say what characters are "fundamental" and hence to what extent this resemblance is superficial. But there seems to be no other species of *Dudleya* more closely approaching *D. stolonifera*.

Dudleya edulis is an unquestioned member of the subgenus Stylophyllum, being in fact the type species. The occurrence of an apparently fertile hybrid between *D. edulis* and *D. stolonifera* suggests a close relationship between these two species and might therefore appear to suggest that they be placed in the same subgenus. Little evidence is available, however, concerning crossability in *Dudleya*.

Although the species of *Dudleya* included in the subgenus Stylophyllum (Moran 1942) seemed to form a natural group, the only reliable character for separating them from Eududleya appeared to be in the attitude of the carpels. Since its carpels are spreading, *D. stolonifera* would appear on this basis to belong to Stylophyllum. However, its broad rosette leaves and erect bright yellow petals suggest Eududleya. Since the plant which it most closely resembles is a member of Eududleya, *D. stolonifera* is tentatively placed in the subgenus Eududleya.

This treatment invalidates the one diagnostic character which appeared reliable for the separation of Eududleya and Stylophyllum, namely the attitude of the predehiscent carpels. These two groups now appear less distinct than they did before and less worthy of the rank of subgenera. Nevertheless, they do not seem entirely artificial and hence are maintained for the present.

LITERATURE CITED

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FLEAS OF THE STATE OF NEVADA

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This paper on the fleas of the State of Nevada fits geographically between the works of J. S. Stanford in Utah; the works of Gus Augustson in the Central Sierran region of California and Pacific Southwest; and the works of C. A. Hubbard in the Pacific Northwest. As far as the writer knows he is the only student of the fleas in Nevada. The last several years he has made four trips a year (March, June, September, December) through the state, entering at Vya in the northwest corner, traveling south along the west border to Searchlight in the southern tip, thence north along the east border to Wells and Contact in the northeast corner, then west to Reno.

Ten years have elapsed since the writer first entered the state to set traps at McDermitt, Humboldt County, on July 8, 1939. During 1940 he reported 10 species and subspecies from the state, in 1943, 14; in 1947, 36; and at this writing 62.

This study shows that the fleas of Nevada are Rocky Mountain along the eastern border, Oregonian along the northern border, Cascadan on the western border north of Lake Tahoe, and south of it Sierra Nevadan.

The great majority of the fleas of the state are off rodents and as any siphonapterist soon learns fleas off predators are generally the fleas of the rodents caught for food, therefore a good survey of rodent fleas brings to light most of the fleas of the state. Moles, shrews, bats and birds may add one or two species each. The following study is, then, primarily a study of the fleas of the rodents of Nevada.

The study also shows that certain Nevada fleas are seasonal in their appearance.

"Mammals of Nevada" by Hall from the University of California Press, 1946, and "Fleas of Western North America" by Hubbard from Iowa State College Press, 1947, are the sources used. So that the reader can readily refer to these the writer has placed after the flea name in brackets first in italic numbers the page upon which the flea description is found in Hubbard, followed by the number of the page in Hall upon which the description of the host is found, thus:

Monopsyllus w. wagneri off *Peromyscus m. gambeli* [*221*-513].

To further facilitate the study of fleas of Nevada the writer has sent to the National Museum to become part of his Master Collection, there, a hundred capacity case entitled "The Fleas of Nevada" in which the student will find the fleas upon which the records are based. A similar case is sent to the California Academy of Science, and a case almost as complete to Los Angeles County Museum, and University of Nevada.

The generic sequence used here is the same found in all check-lists of Hubbard.

In the first section of the paper, which follows, only the writer's own records appear.

1. *Hoplopsyllus affinis* (Baker) 1904 [*71*-612], a Rocky Mountain rabbit flea was taken off the Cottontail, *Sylvilagus, a. arizonæ* at Las Vegas, Clark county, on June 29, 1945.
2. *Hoplopsyllus g. foxi* Ewing 1924 [*68*-610], has been taken off *Sylvilagus n. nuttalli* in the extreme northwestern corner of the state in Washoe county.
3. *Hoplopsyllus anomalus* (Baker) 1904 [*72*-314-495], has been taken during June the entire length of the state through the range of *Citellus l. leucurus,* off this Antelope Ground Squirrel and off Southern Grasshopper Mouse, *Onychomys torridus longicaudus,* at Alamo and Searchlight. This is a summer flea and a very efficient vector of plague.
4. *Cediopsylla i. inæqualis* (Baker) 1895 [*74*-607], the small Great Basin rabbit flea has been taken off Cottontails throughout the state.
5. *Anomiopsyllus amphibolus* Wagner 1936 [*83*-528], described from the Rocky Mountains has been taken off *Neotoma l. lepida* at Beatty, Nye county, during December of 1947.
6. *Orchopeas sexdentatus agilis* (Rothschild) 1905 [*93*-528]. The writer is inclined to believe that the flea he has taken off *Neotoma l. lepida* through the southern portion of the state is Rocky Mountain, therefore *O. s. agilis.*
7. *Orchopeas sexdentatus nevadensis* Jordan 1929 [*95*-530], with expanded terminal portion in lobe of VII st. female, is, this writer believes, confined to the northwest quarter of the state. He has it off *Neotoma l. nevadensis* from Washoe county and adjacent Oregon and California.

The Public Health Service reports that in 1938 field workers in Clark county, Nevada noticed large numbers of deserted wood rat nests. Plague was suspected, but in no animals examined was the disease found. 1500 fleas taken from the area and designated

in part as *O. s. nevadensis* proved plague positive. It is probable that *Orchopeas sexdentatus,* regardless of subspecies, is a vector of plague and wood rats and their fleas should constantly be watched for possible reservoirs.

8. *Orchopeas nepos* (Baker) 1904 [*99*-352], the Cascade Pine Squirrel flea has been taken off *Tamiasciurus d. albolimbatus* on Incline Creek, Lake Tahoe, Washoe county, September 12, 1948.

9. *Orchopeas leucopus* (Baker) 1904 [*105*-511], has been taken all over the state off *Peromyscus maniculatus* and off *Microdipodops m. oregonus* at Hausen, Washoe county, during June of 1944 and 1945.

10. *Opisodasys keeni* (Baker) 1896 [*110*-511], a northwest Deer Mouse flea has been taken as far south in the state as Carson City and Ely off *Peromyscus maniculatus.*

11. *Opisodasys vesperalis* Jordan 1929 [*113*-353], the western Flying Squirrel flea was taken off *Glaucomys sabrinus lascivus* at Incline Creek, Lake Tahoe, Washoe county, September 12, 1948.

12. *Thrassis jellisoni* Hubbard 1940 [*124*-308], described from Humboldt county off *Citellus b. oregonus* has also been taken off the Oregon Ground Squirrel at Vya, Washoe county, during June and July.

13. *Thrassis h. howelli* Jordan 1925 [*128*-286], the California Marmot flea has been taken only in Washoe county off *Marmota f. avara.* Marmots have always been looked upon with suspicion as far as plague is concerned, therefore their fleas early became center of plague investigation. It is reported that 33 per cent of 16 fleas of this subspecies experimented with became infected with plague and 17 per cent of these transmitted plague to guinea pigs.

14. *Thrassis rockwoodi* Hubbard 1942 [*132*-300, 308], has been taken off *Citellus b. oregonus* and *Citellus t. canus* in the northwest corner of the state.

15. *Thrassis francisi* C. Fox 1927 [*134*-301-495], an eastern Nevada ground squirrel flea has been taken off *Citellus t. mollis* during July 1945 at Ely, White Pine county, and off Grasshopper Mouse, *Onychomys torridus longicaudus* at Alamo, Lincoln county during April, 1948.

Both *Thrassis rockwoodi* and *francisi* are considered vectors of plague.

16. *Thrassis gladiolis gladiolis* Jordan 1925 [*135*-314, 495], is a year around flea of *Citellus l. leucurus* which ranges over all of western and southern Nevada. The writer has it off this Antelope Ground Squirrel throughout its range and off Grasshopper Mouse at Searchlight, Clark county. The flea is considered a plague vector.

17. *Thrassis gladiolis johnsoni* Hubbard 1949 [-560], has been taken off *Lagurus curatatus intermedius,* the Sagebrush meadow mouse at 49 Ranch; 4 miles west of Vya, Washoe county during 1949.

18. *Thrassis arizonensis arizonensis* (Baker) 1898 [*138*-424], can be reported only as a single specimen taken as a stray off *Dipodomys m. merriami,* Kangaroo rat, at Las Vegas, Clark county on January 1, 1947.

19. *Thrassoides hoffmani* Hubbard 1949, is a common winter flea of Kangaroo rats all over southern half of Nevada and adjacent California, Arizona north of Colorado River and Utah. It is found as a stray on Deer Mice.

20. *Diamanus montanus* (Baker) 1904 [*147*-289], is found all over the state where there are ground squirrels. The flea is a vector of plague.

21. *Opisocrostis tuberculatus tuberculatus* (Baker) 1904 [*152*-308], has been taken off Oregon Ground Squirrel, *Citellus b. oregonus* at Vya, Washoe county during June, 1945. The flea is a plague vector.

22. *Opisocrostis labis* (J. and R.) 1922 [*156*-301], has been taken off *Citellus t. mollis,* Townsend Ground Squirrel at Ely, White Pine county, July 13, 1945. This flea is considered a vector of plague.

23. *Opisocrostis oregonensis* G. and P. 1939 [*160*-308], has been taken off *Citellus b. oregonus* at Vya, Washoe county during June, 1945.

24. *Oropsylla idahoensis* (Baker) 1904 [*163*-308], is the most common flea found on ground squirrels in Washoe county during June. It is widely spread in the state.

25. *Foxella ignota recula* (J. and R.) 1915 [*176*-434], the small northwest pocket gopher flea has been taken off pocket gophers in Washoe, Lander, Humboldt and Douglas counties.

26. *Foxella utahensis arizonensis* Hubbard 1947 [*184*-471], was taken off *Thomomys b. centralis* at Alamo, Lincoln county on April 29, 1948.

27. *Dactylopsylla bluei* (C. Fox) 1909 [*191*-471], one of the giant pocket gopher fleas is found abundantly through southern Nevada in winter. The writer collected a large series off *T. b. centralis* at Beatty, Nye county during December 1946, 1947, and April 1948.

28. *Dactylopsylla monticola* Prince 1945 [*193*-451], has been collected at Lake Tahoe, Washoe county.

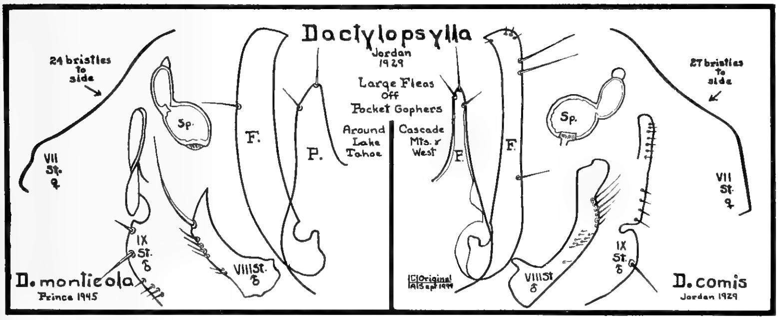

PLATE 17

THE ALLOTYPE MALE

When Prince described this flea in Canadian Entomologist *77*:17, 1945 the male had not yet been collected. He associated it with *D. bluei.* Male specimens in the hands of the writer lead him to believe *monticola* is more closely associated with *comis.*

There are before the writer at this time the allotype male, 5 paratype males and a good series of females taken north and west of Lake Tahoe at Incline Creek and Tahoe Meadows August 1949 off *Thomomys m. monticola.*

Modified segments: Male. Both process and finger are of the *comis* shape, but more squat and plump. The finger is apically hooked anteriorly, and scythe-blade shaped. The process is not long and slender as in *comis* but much shorter and broad. The VIII sternite is neither *bluei* or *comis*-like but instead in the shape of a hook with a major bristle and a series of 5 or so medium bristles below it on ventral border. The IX sternite is of the pattern of *comis.*

Length: The male measures 3.50 mm., the female 4.50 mm.

Range: Probably all about the Lake Tahoe region of Nevada and California on *Thomomys m. monticola,* the Mountain Pocket Gopher.

DEPOSITES: The allotype male is being sent to the United States National Museum and bears the writer's number 2730 and collection data as follows: Tahoe Meadows, 8600 ft. elevation, Washoe county, Nevada. Paratypes with same data are being sent to depositories maintained by the writer. The holotype female collected west of Carson City in Ormsby county on August 19, 1937 is deposited in the Plague Suppressive Measures Laboratory at San Francisco.

29. *Malaræus telchinum* (Rothschild) 1905 [*198*-502], a Deer Mouse flea has been secured all over the state north of Kyle Canyon. Burroughs working during 1944 at Hooper Foundation found this flea to be a very efficient vector of plague.

30. *Malaræus sinomus* (Jordan) 1925 [*201*-502], is very common in the south on Deer Mice but in the northern part of the state it is uncommon.

31. *Malaræus euphorbi* (Rothschild) 1905 [*206*-513]. During October of 1944 the writer took a series of fleas off *Peromyscus m. gambeli* at Vya, Washoe county which he determined as *M. bitterrootensis,* as did Augustson for specimens from the central Sierras, but Prince studying these during 1949 redetermined them as *M. euphorbi.*

32. *Megabothris abantis* (Rothschild) 1905 [*213*-184], has been taken off *Microtus montanus micropus* at Vya, Washoe county, during June of 1945; off a small short-tailed weasel at Incline Creek, September 12, 1948; off Zapus at Marlette Lake, August 27, 1949.

33. *Megabothris princei* Hubbard 1949 [-560], has been collected off Lagurus, the Sagebrush Vole, west of Vya, Washoe county during 1949. This flea was also taken at Ft. Bidwell, California.

34. *Megabothris asio orectus* Jordan 1938 [*216*-546], was recovered from the nests of *Microtus montanus* on 12 Mile Creek northwest Washoe county during August 1949. Many of the mice examined did not carry the flea which is probably a nest flea of this meadow mouse. This flea was also taken at Ft. Bidwell, Modoc county, California.

35. *Monopsyllus wagneri wagneri* (Baker) 1904 [*221*-502, 571, 497, 493], the common Great Basin Deer Mouse flea has been collected over most of Nevada north and east of Carson City. It has been taken off Deer Mouse, House Mouse and Harvest Mouse at Reno and Grasshopper Mouse at Wells.

36. *Monopsyllus wagneri kylei* Hubbard 1949 is the variation from *M. w. wagneri* found in southern Nevada on Deer Mice.

37. *Monopsyllus ciliatus mononis* (Jordan) 1929 [*233*-345], is found on the large Townsend chipmunk around Lake Tahoe, where it was collected at Incline Creek, Washoe county, off *Eutamias t. senex* on September 13, 1948 and south end of Lake Tahoe, Douglas county, June 21, 1944. It has also been taken off Pine Squirrel at Incline Creek. The flea has been proved a vector of plague.

38. *Monopsyllus eumolpi eumolpi* (Rothschild) 1905 [*237*-326], is the common flea found all over the state on the Desert chipmunk, *Eutamias minimus,* and other Nevadan chipmunks found within the state.

39. *Monopsyllus eumolpi charlestonensis* Hubbard 1949 is found on Palmer's chipmunk and other chipmunks of Spring Mountain, northwestern Clark county.

40. *Odontopsyllus dentatus* (Baker) 1904 [*266*-607], has been taken off Cottontail at Vya, Washoe county. It is the large western wild rabbit flea.

41. *Callistopsyllus terinus* (Rothschild) 1905 [*281*-515], is a seldom taken Deer Mouse flea which the writer has collected off *Peromyscus m. sonoriensis* all about the shores of Lake Tahoe.

42. *Catallagia decipiens* (Rothschild) 1915 [*288*-513], has been taken often off Deer Mice in the northwestern portion of the state.

43. *Stenistomera alpina* (Baker) 1895 [*305*-528], was taken in large numbers from a few *Neotoma l. lepida* collected at Beatty, Nye county on December 27, 1947. The writer has not collected it at other seasons of the year.

44. *Epitedia stanfordi* Traub 1944 [*312*-513, 497], has been collected at Carson City off Deer Mouse during December, 1946 and off Harvest Mouse March, 1945.

45. *Neopsylla inopina* Rothschild 1915 [*314*-308, 515], was taken off *Citellus b. oregonus* at Vya, Washoe county from the colonies at 49 Ranch during June 1945 and during July of 1939 in Humboldt county. It was collected off Deer Mouse south end of Lake Tahoe, Douglas county, June, 1944.

46. *Meringis dipodomys* Kohls 1938 [*320*-403], is the common all year around kangaroo rat flea of Nevada. It is plentiful in the south but rapidly fades out in the north.

47. *Meringis cummingi* (C. Fox) 1926 [*321*-420], has been taken off *Dipodomys microps aquilonius* in south end Surprise Valley, Washoe county.

48. *Meringis parkeri* Jordan 1937 [*323*-403], is the common kangaroo rat flea of northern Nevada. The writer has not found it in the southern half of the state.

49. *Meringis hubbardi* Kohls 1938 [*326*-502, *377*, 357], has been taken off Deer Mice, Gnome Mice and Pocket Mice in northern Nevada.

50. *Peromyscopsylla hesperomys* (Baker) 1904 [*329*-502], has been collected as far south in the state as Beatty, Nye county, off Deer Mice.

51. *Peromyscopsylla selenis* (Rothschild) 1906 [*333*-546], was taken off *Microtus m. yosemite* on Incline Creek, Lake Tahoe, Washoe county on September 12, 1948.

52. *Peromyscopsylla ravalliensis* (Dunn) 1923 [*332*-515], seems way out of range at Beatty, Nye county, where the writer collected it off Sonoran Deer Mouse on December 30, 1946 but Augustson is recorded as having taken it in the early 1940s across the state line in the high Sierra Nevadas of California.

53. *Carteretta carteri* C. Fox 1927 [*341*-515], a California flea distinctly out of place in Nevada was taken by the writer off Sonoran Deer Mouse at Beatty, Nye county on December 30, 1946. California records suggest this flea a winter one.

54. *Doratopsylla jellisoni* Hubbard 1940 [*344*-502], a northwest shrew flea was taken by the writer off Deer Mice at Reno, Washoe county and in Douglas county at Lake Tahoe.

55. *Micropsylla sectilis* (J. and R.) 1923 [*349*-], is a small flea taken often in northern Nevada off various rodents in winter and spring.

56. *Actenophthalmus heiseri* (McCoy) 1811 [*352*-314], is a winter flea of *Citellus l. leucurus*. The writer took this flea off the Antelope Ground Squirrel the entire length of the state in December of 1947.

McCoy in describing this flea in 1911 did not have the male and no host data was mentioned. He placed it in the genus *Ctenophthalmus*. Carroll Fox not satisfied with this generic designation erected in 1925 the new genus *Actenophthalmus* to hold the flea and designated it as genotype.

The writer has before him at the time of this comparing 25 pairs of *M. sectilis*, 25 pairs of *M. goodi* and a good series of *A. heiseri* and from them he redescribed the genus *Actenophthalmus* as follows: Very close to *Micropsylla*. Head bullet shaped as in *Micropsylla*. Arrangement of genal teeth same in both genera, 4 or 5 in Micropsylla, 5 in known *Ac-*

tenophthalmus arranged with roots in a gentle arc on the border of the gena and all teeth with their roots close together. No irregularity in arrangement as suggested by all illustrations to date. Above genal teeth 2 heavy long bristles in *Actenophthalmus,* 3 in *Micropsylla,* in each case extending far beyond genal teeth. Second row of genal bristles medium, 4 to 6 in number. Many bristles on post-antennal region in 3 rows.

Pronotal Comb of about 18 dark heavy teeth as in *Micropsylla.* Antepygidial bristles also as in *Micropsylla,* none in male, 2 in female. Modified segments in male as in *Micropsylla.* Spermatheca of *Actenophthalmus* in shape of that found in *Micropsylla* but with apex expanded not compressed as in *Micropsylla.* Lateral plantar bristles 6 pairs to tarsal segment V of each leg, *Micropsylla* with but 4.

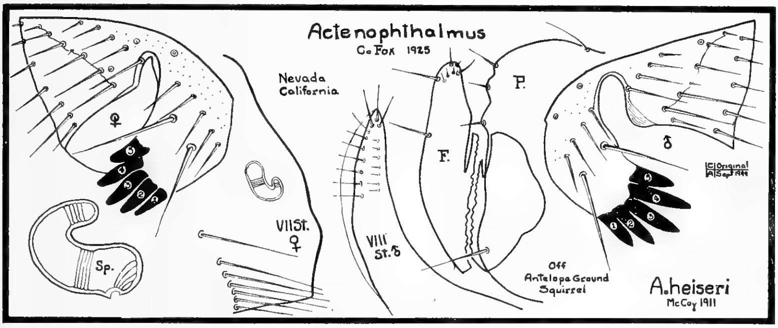

PLATE 18

THE ALLOTYPE MALE

There are before the writer at this time the allotype male, ten paratype males and 25 females collected in Nevada during December of 1947 off the Antelope Ground Squirrel.

Modified segments: Male. Very similar to the pattern found in the flea *Micropsylla goodi* Hubbard, and frequently confused with it. The process of the clasper is large and bulky, rounded apically and on the posterior border a series of small triangular prominences each armed with a bristle. The finger is very small in comparison to the size of the process and has an unusually large articulating surface with the process. The exposed portion of the finger might be called finger shaped. It is armed with a medium bristle at posterior apical angle, another of about equal size well below it and a short bristle at the anterior apical angle. The apex is well clothed with short bristles. The VIII sternite is hooked

and very prominent and covered with bristles of various sizes.

Length: The specimens before the writer are considerably larger than indicated for the holotype female, and measure male 2.75 mm., female 3.50 mm.

Range: Probably throughout the range of *Citellus l. leucurus,* the true host, which is from southeastern Oregon, through all of western Nevada and parts of eastern California. The holotype is from Mojave, California, the allotype from Carson City, Nevada.

Deposites: The allotype male is deposited in the National Museum and paratypes are being sent to depositories maintained by the writer. In each case slides bear the writer's number 2621 and the date December 24, 1947 off *Citellus l. leucurus* at Carson City, Nevada.

The female, known since 1911, has a high undulate outline on VII sternite. The spermatheca has no definite junction between body and appendix, the latter curving nicely over the former. The apex of the appendix is fully expanded, not compressed as in *Micropsylla.*

This flea further resembles species of *Micropsylla* in that it is taken mostly in winter months.

57. *Hystrichopsylla gigas dippiei* Rothschild 1902 [*357*-515], has been taken off Deer Mice in Charleston Park northwest of Las Vegas in Clark county and far to the north in extreme northwest Washoe county out of the nests of *Microtus montanus.*

Records from other Sources and Doubtful Ones

58. *Thrassis gladiolis cauducus* Jordan 1930 [*137*-289], has been reported off *Citellus* from Baker, White Pine county.

59. *Nosopsyllus fasciatus* (Bosc) 1801 [*207*-569], the common European rat flea was reported by Prince in 1943 from Reno and Sparks, Washoe county, off rats.

60. *Orchopeas sexdentatus schisintus* Jordan 1929 [*97*-403]. A female flea suggestive of this species was taken off a Kangaroo rat at Las Vegas, Clark county January 1, 1947. Both host and locality are wrong, however. This flea should not be west of Colorado River and generally rides only on Wood rats.

61. *Thrassis setosis* Prince 1944 [*141*-515]. A male and female flea taken off a Deer Mouse at Searchlight, Clark county suggests this species. This flea should not be found west of Colorado River.

62. *Myodopsylla gentilis* J. and R. 1921 [*374*-129] was identified by the writer from material taken off *Macrotus californicus,* California long nosed bat by Professor La Rivers of the University of Nevada. The bats were reported taken in the Nightingale Mts. July 24, 1946.

FLEAS TO BE LOOKED FOR IN NEVADA BUT NOT YET RECORDED FROM THE STATE

After 30 years of study devoted to the fleas of western states, the writer feels that predictions can be made as to the appearance of unreported fleas if the proper host is present. These predictions give a field of research for new students in the study of siphonaptera.

1. *Echidnophaga gallinacea* (Westwood) 1875 [*50*-], the Sticktight or Tropical Hen flea may possibly have been reported from the state. It is common in joining states on ground squirrels, wild mice and at times poultry.

2. *Pulex irritans* Linnæus 1758 [*57*-], the human flea is common in surrounding states in dwellings and in and around pig pens. The flea is also found on coyotes, skunks, deer and many other wild animals.

3. *Ctenocephalides felis* (Bouche) 1835 [*60*-], the common cat flea is doubtless found in the state as a household pest.

4. *Ctenocephalides canis* (Curtis) 1826 [*52*-], the common dog flea is usually not so common in the West as is the preceding. It should, however, be found on dogs in the state.

5. *Xenopsylla cheopis* (Rothschild) 1903 [*65*-], the Oriental rat flea should in time show up on domestic rats where their population is heavy. Prince did not record this flea from Nevada in his rat flea study of 1943.

6. *Anomiopsyllus nudatus* (Baker) 1898 [*79*-], a wood rat flea of southern California and Arizona should show up in southern Nevada on wood rat. There is no barrier to keep it from coming in from California.

7. *Amphalius necopinus* (Jordan) 1925 [*170*-], was described off Muir's Pika from Mono county, California. It seems likely that this flea will be found on the same cony in Nevada around Lake Tahoe. Shelton's Cony farther to the south around Mustang Mt. in Esmeralda county should also carry this flea.

8. *Monopsyllus exilis exilis* (Jordan) 1939 [*243*-], the true flea of Grasshopper Mice should be found on the various Grasshopper Mice of the state.

9. *Ceratophyllus garei* Rothschild 1902 [*253-*], is found commonly in the nests of water fowl in south central Oregon and therefore it should show in the nests of the same birds on the lakes of northwest Nevada.

10. *Dolichopsyllus stylosus* (Baker) 1904 [*264-*], should be found on the Mountain Beavers (*Aplodontia*) which Hall reports from Marlette Lake and Lake Tahoe, Washoe county.

11. *Augustonius ashcrafti* Augustson 1941 [*269-*], will probaby be found on Muir's and Shelton's cony in western Nevada.

12. *Ctenophyllus terribilis* (Rothschild) 1903 [*270-*], should be found in the northwest corner of the state on *Ochotona p. schisticeps.*

13. *Atyphloceras multidentatus* (C. Fox) 1909 [*276-*], and others of the 4 species of this genus in California should come to light on mice in the state.

14. *Callistopsyllus deuteros* Jordan 1937 [*283-*], should be found on mice in western Mineral and Esmeralda counties.

15. *Megarthroglossus procus,* [*297-*], in some subspecies should appear on *Tamiasciurus* around Lake Tahoe in winter.

16. *Epitedia wenmanni* (Rothschild) 1904 [*310-*], should be found on Deer Mice at Lake Tahoe and Marlette Lake, Washoe county during Fall.

17. *Phalacropsylla monticola* Augustson 1941 [*339-*], may be taken off Muir's and Shelton's cony in western Nevada.

18. *Phalacropsylla allos* Wagner 1936 [*340-*], can be looked for in eastern Nevada on wood rats.

19. *Hystrichopsylla schefferi* Chapin 1919 [*359-*], may be found on Mountain Beaver (*Aplodontia*) at Marlette and Tahoe Lakes in Washoe county.

20. *Corypsylla* [*363-*], found on moles should appear on the western border of the state north of Mineral county. What species will show is hard to predict, although *C. ornata* is the common mole flea all over the West.

21. *Nearctopsylla* [*368-*], another genus of mole flea should appear with the preceding in Nevada.

22-25. Because of the large number of bats listed by Hall from the state, the writer believes, when they are studied, that they will be found to carry at least four types of fleas.

Host Index

SIPHONAPTERAN PROBLEMS STILL UNSOLVED IN NEVADA

Probably the most interesting problem still unsolved among Nevada rodents is the cony fleas. The writer feels that a state-wide survey of Ochotona would add to the list of known Nevada fleas at least 6 species. Aplodontia, the Mountain Beaver, presents another problem. In a mythical way these primitive little burrowing animals have been reported about Marlette Lake. If found they should carry 3 of their own fleas as they do all over their range There is some question that Beavers and Muskrats carry fleas. The question might be answered in Nevada.

While moles are found only along the California boundary in the north half of the state, shrews are fairly well represented over the state. The fleas of these Insectivora would make an interesting study.

Brachylagus and Lepus when studied will probably carry the same fleas as Sylvilagus. This is the case in other western states. The writer has had no experience with the rodent Sigmodon. Hall reports taking 15 one-half mile north Calif.-Nev. Monument on the Colorado River in Clark county. One wonders if this Cotton rat has brought *P. gwyni* into Nevada.

Hall devotes 40 pages in his manual Mammals of Nevada, to bats but Hubbard uses only 8 pages in Fleas of Western North America to describe all western bat fleas. In spite of the few known bat fleas their study in Nevada should prove interesting.

There has been little study given to the bird fleas of the West. They have generally failed to interest the student. Bird fleas are seldom gathered from the birds but rather from the nests of birds. Bank swallows and burrowing owls and birds which build in man's bird houses or in tree cavities usually have nests which teem with fleas. After removing fleas from nesting materials the material and debris should be placed in paper sacks, kept moist and from time to time examined. Most larva will pupate and emerge as fleas in due course.

When all sources have been thoroughly explored the writer predicts 90 species and subspecies of fleas for Nevada. This is comparable to the 95 listed by him for Oregon and 105 for California.

HYDRADEPHAGOUS COLEOPTERA OF THE NEVADA AREA, EXCLUSIVE OF THE DYTISCIDÆ

By IRA LA RIVERS
University of Nevada, Reno

CARABOIDEA
(Amphizoidæ)

This monogeneric family of rather odd and unique water beetles is still not common in collections, nor is its biology well-known. Members of the family are known only from the northwestern United States, adjacent Canada and a small portion of northeastern Asia. They are mountainous forms preferring cold, swift water and such poor swimmers that crawling is their only efficient means of transportation in water. Oddly enough, the first United States species was placed in the family Tenebrionidæ, which has no known aquatic species. Of the little which has been published concerning the family, Darlington's notes (1929) are probably the most applicable:

"The three species have mutually similar habits. They occur chiefly in two sorts of places, either in gravel at water level along the banks of streams, or in masses of floating trash which have gathered against obstructions. In the first case they are nearly always at the side of an eddy or at a curve in the stream, or where for some reason the current is throwing up detritus . . . In favorable places the shores are often so undercut that the beetles must be sought in shallow caves or under overhanging rocks. Good collecting may be found in both swift and comparatively slow brooks, but in the latter the Amphizoa are usually in the rapid stretches.

"From all this it will be seen that the species of Amphizoa live in cover where a brook or the current set up by a wind will bring them food, and it is a fair deduction that the insects are in some part scavengers, although I have never seen them feeding. I do not know whether they travel much, but I knocked down a single *lecontei* as it flew over the lake at Banff" (Alberta, Canada).

"The beetles may be taken easily once their haunts have been discovered. Where they are among rocks or in gravel, the bank is dug out at water level, and raked a little at a time into the brook; where they are in floating material, the latter is spread out on the water and beaten with a stick or the flat of the hand. The treatment in either case is to dislodge the beetles and separate them from the cover. When this is done, they swim slowly with their backs breaking the surface, for they cannot dive.

"Amphizoa emits an odor which is rather pleasant, at least to the collector, and which Horn compares to that of decaying wood. The beetles also exude a thickish, yellow fluid from the joints, so that they leave a cigarette-like stain on the fingers."

(AMPHIZOA Le Conte 1853)

Since there is still much to be learned of the total distribution of these insects, Van Dyke's second 1927 key to the genus is included; all three species in the United States are known only from the Far West, and none has yet been found in Nevada, although the possibility of *A. insolens* occurring in the State is hardly to be doubted.

1. Elytra flattened at middle; (fifth interval strongly elevated; prothorax hardly sinuate in front of hind angles, in general broadest at base; color black or somewhat rufous in places; elytra almost smooth; average length 12-13 mm. British Columbia through Rocky Mountains to Alberta, Idaho, and Wyoming) . . . . (*lecontei* Matthews 1872)
— Elytra evenly convex from side-to-side..................2

2. Prothorax deeply sinuate in front of hind angles, in general broadest at middle and markedly crenulate along lateral margin anteriorly; color coal black; elytra very irregularly and coarsely rugose especially at sides; average length 12 mm. Alaska, British Columbia, Cascade and Sierra Nevada Mountains to Mount San Bernardino, California................ ....(*insolens* Le Conte 1853)
— Prothorax hardly sinuate in front of hind angles, generally broadest at base; color black with sides of prothorax, elytral intervals and parts of underside somewhat rufous; elytra almost smooth; average length 14 mm
Northbend, Washington . . .(*striata* Van Dyke 1927)

HALIPLIDÆ

These interesting little insects are poor swimmers, relying mainly upon crawling in both larval and imagine stages, and are herbivorous. Adults have the hindcoxæ enormously enlarged into flat plates, which are an integral part of their underwater respiratory mechanism. Wilson (1923) has summarized this function in the haliplids as:

"....the elytra are held firmly in place by groovings in the pleura and by knoblike structures at the outer ends of the posterior coxæ. The latter project backward far enough to cover from three to five abdomen segments. The posterior end of the body is thrust out of the water, and air is admitted to the space between the broad posterior coxæ and the ventral surface of the

abdomen. This air finds its way to the reservoir beneath the elytra through a groove in the pleurum at the anterior end of each coxa. The structural modifications in this family" (for respiration) "thus include the peculiarly modified posterior coxæ, the grooves leading to the dorsal reservoir, and the enlargement of the metathoracic and first abdominal spiracles."

Unlike the majority of aquatic beetle larvæ, the young haliplids need not come to the surface for air, but either possess chætæ on the thoracic and abdominal lateral and dorsal surfaces which contain fine tracheoles capable of obtaining oxygen directly from the water, or accomplish the same result through thoracic and abdominal spiracles. As far as known, the larvæ feed exclusively upon algæ, and crawl a greater distance from the water's edge than most aquatic beetles when ready to pupate; pupation is carried out in an earthen cell. Whereas the larvæ are extremely sluggish when moving about, the adults are agile walkers, and when swimming, swim slowly with an alternate movement of the legs.

GENERA KNOWN OR OF POSSIBLE OCCURRENCE IN NEVADA

Adults

1. Hind coxæ margined, reaching to base of last sternite their lateral margins parallel with, and covering inner parts of, the epipleura; elytra on apical half with a finely-incised stria near suture; last palpal segments larger than penultimate segments . . . . PELTODYTES
— Hind coxæ not margined, reaching only to apex of third sternite, their sides posteriorly diverging from inner edge of epipleura; elytra without fine sutural stria; last palpal segment smaller than penultimate segment. 2

2. Pronotum flat, on each side with a longitudinal stria, often reaching to the anterior fourth (except *parvulus*), the sides parallel in anterior half, narrowing anteriad; hind claws about as long as second tarsal segment. . . . . (Brychius)
— Pronotum convex, without longitudinal stria, or with a short one which does not reach anteriad of basal third of pronotum, sides of which are narrowed caudad to cephalad; hind claws about half as long as second tarsal segment. . . . . (Haliplus)

LARVÆ

Abdominal tip pointed, ending in two filiform setæ; body segments with short triangular appendages. . . . . (Haliplus)

Abdominal tip bluntly rounded; body segments with filiform tracheal appendages as long as body itself. . . . . . PELTODYTES

PUPÆ

Wings loosely held against body and very rough; styli in form of short, triangular spines........................(Haliplus)
Wings folded tightly against body and smooth; styli in form of long, curved, linear spines, not segmented.......PELTODYTES

(BRYCHIUS J. Thompson 1860)

B. horni Crotch 1873 is the only species to be looked for in Nevada, being known from adjacent California.

(HALIPLUS Latreille 1802)

SPECIES OF POSSIBLE NEVADA OCCURRENCE

(Wallis 1933A)

1. Species with basal pronotal plicæ........................2
— Species without such plicæ..........................5

2. Basal pronotal plicæ shorter, less than one-quarter length measured from plical base along plica to anterior margin of pronotum 3
— Plicæ longer, more than one-quarter such length..........4

3. Prosternal process rather deeply channeled longitudinally, especially over declivity; head width between eyes less than one-half total head width; elytral maculation usually distinct, consisting of six black spots in a half ellipse, enclosing a common sutural blotch; in extreme cases, the maculation may almost entirely disappear ......(*immaculicollis* Harris 1828)
— Prosternal process rather feebly and narrowly channeled; head width between eyes one-half or more than total head width; elytra without black markings of any kind; the more widely-spaced punctures are a little darker than the ground color and occasionally some of their color extends from clusters of punctures to form indefinite brownish spots.........
..........................(*robertsi* Zimmermann 1924)

4. Prosternal process evidently channeled.....................
.....................(*dorsomaculatus* Zimmermann 1924)
— Process not or very feebly channeled (*longulus* Le Conte 1850)

5. Prosternal ridge not margined at sides, or at most only feebly so near apex..6
— Ridge plainly margined at sides........................7

6. Elytral humeri asperate..........(*tumidus* Le Conte 1880)
— Humeri not asperate.............(*concolor* Le Conte 1852)

7. Mid-metasternum depressed behind middle coxæ...........
.... (*gracilis* Roberts 1913)

— Mid-metasternum about on same level behind as between mid-coxæ, with a circular or subtriangular fovea at middle ....(*subguttatus* Roberts 1913)

All the above *Halipli* are known from the adjacent Pacific Coast, and most of them may occur in Nevada.

PELTODYTES Regimbart 1878

Our species are (Roberts 1913):

1. Elytron with a distinct callosity..................*callosus*
— Elytron without such a callosity........................2

2. Apex of prosternal process not distinctly margined..*simplex*
— Apex of prosternal process distinctly margined.............
..............................(*dispersus* Roberts 1913)

P. CALLOSUS (Le Conte) 1852. Washoe County (*Truckee Meadows* (Reno) 5/IV/41, el. 4500 ft. -LaR). This small species is common in ponds about Reno, and undoubtedly has a much wider distribution in the State. Le Conte described it from San Francisco and San Diego (California) specimens.

P. SIMPLEX (Le Conte) 1852. Nye County (*Beatty* (Amargosa River) 29/XII/46, el. 3375 ft. -LaR, T. J. Trelease, B. H. Banta and R. G. Miller). This was taken in large numbers from a small slough lying adjacent to the icy Amargosa River (see *Hydroscapha natans*), a slough which seemed slightly warmer than the river itself, never freezing at night.

P. dispersus, recorded from Arizona and Utah, may be a synonym of *P. simplex* (fide Chandler 1946). My Nevada specimens seem to be intermediates between the two species.

Wilson (1923) says of *P. edentulus* (Le Conte) 1863 in the Mid-West:

"The eggs are fastened individually to filaments of Nitella or Chara. The average time required for hatching is about two weeks.

"This larva can only crawl about slowly over the algæ, trailing its long spines. It can not run or swim at all, but it is a most persistent crawler and, when hunting for a place to pupate, travels a longer distance from the water's edge than any other larva studied, except that of the gyrinid (*Dineutes americanus*).

"It is the only larva that constantly refused to pupate in an artificial mud cell. It always persisted in crawling out and making its own pupal chamber somewhere else. In spite of its porcupine coat of bristles it can burrow readily into mud considerably hardened. It feeds entirely upon filamentous algæ, such as Spirogyra

and Mougeotia, and the structure of its mouth parts and legs is peculiarly adapted to this sort of food. It breathes through tracheoles in the long jointed spines, and thus has no need to come to the surface for air. It has no visible spiracles.

"From 20 to 25 days after hatching the larva is ready to pupate. It crawls a long distance from the water's edge and forms its pupal chamber in rather dry mud. Into this it pushes for half an inch or more and there hollows out a spherical chamber about 5 mm. in diameter. It remains inside of this chamber from four to six days before transforming. The jointed spines are all discarded with the larval skin; of course many of them get broken during the formation of the pupal chamber, especially the long, narrow ends where the tracheoles are located. It would seem, therefore, as if the spiracles must begin to function before the transformation has taken place. They become visible during this prepupal period, and with the disappearance of the tracheolar spines they assume their proper function.

"The adults swim slowly and with considerable effort, moving the legs alternately as in walking. The tibiæ of the first and second pairs of legs and the tarsi of all three pairs have long fringes of swimming hairs. In marked contrast to their labored swimming they walk and run on land with great agility, but can not, or at least do not, jump at all. They fly readily from pond to pond, but apparently can not cover very long distances. They live among the plants in shallow water and are not found in the open parts of the ponds. As far as observed they feed entirely upon Chara and Nitella."

GYRINOIDEA

GYRINIDÆ

This is a small family of volunteer surface dwellers, the common "whirligig" beetles of pond and stream surface. For the most part, the adults appear to be scavengers, eating available (usually dead) insects floating upon the surface film, and from the nature of their mandibles, may occasionally be vegetarians. The larva of one of the larger species has been noted to consume fish fry under the abnormal conditions occasioned when a pond is lowered and its inhabitants brought into close proximity; this is not surprising, however, since under normal conditions, they are decidedly carnivorous, possessing suctorial mandibles.

The characteristic activity of the adult consists of swift circular or zig-zag motion, generally in company with others of its kind, over the water's surface, and vast swarms are sometimes seen, whirling dizzily about at such speed that well-timed strokes with a net are needed to catch them. Certain species dive readily, and are difficult to approach, but most of them dive only under strong compulsion. As in the Dytiscidæ, extreme telescoping

and streamlining of body segments and contours is present in order to achieve structural rigidity and smoothness for water travel. In addition to the structural modifications mentioned under the Dytiscidæ, both families have concavities in the venter for the reception of the fore- and mid-legs to further reduce drag. A peculiarity of the gyrinids shared by none of the other families under consideration is the complete separation of each eye into two; the upper pair lie above the surface film and so are presumably adapted to air vision, while the lower pair are submerged and are reasonably assumed to be modified for underwater sight.

Like other coleopterous aquatics, gyrinids have specific modifications for respiration under water. Wilson (1923) has admirably summed these up as:

" . . . the lateral or outer margin of each elytron is turned downward and a little inward and its free edge is grooved. The lateral margins of the meso and meta thorax and the anterior abdomen segments are fused and raised into a longitudinal ridge, which fits into the groove along the edge of the elytra, the two locking together like the lateral hinge on a fresh-water mussel. Opposite the junction of the meso and meta thorax is a rounded peg just inside the edge of each elytron, which fits into a socket in the thorax and holds the elytron securely in place. In Dineutes at the posterior end the under surface of each elytron and the upper surface of the abdomen segment immediately beneath it are covered with short hairs, which make a tight joint when the elytra are closed. In Gyrinus the same closing of the joint is accomplished by a transverse ridge, which runs around the posterior end of each elytron on the under surface. The air enters the dorsal reservoir through a groove just inside the posterior end of the turned-down lateral margin of each elytron. In this family, accordingly, the structural modifications for breathing consist in the interlocking margins of the elytra and the body, in the peg for fastening the two together, and in the posterior groove for the admission of air. The spiracles are all about the same size."

Unlike the vast majority of aquatic coleopterous larvæ, gyrinids are capable of extracting oxygen directly from the water by means of lateral abdominal gills. They resemble haliplids in this respect.

While most water beetles require some portion of the air reservoir they take below the surface as part of their hydrostatic equipment, gyrinids have an even more pronounced need for accurate flotation technic since they support themselves upon the surface film. This they accomplish by means of a short hydrofuge pelt covering the venter which entangles a thin, uniform film of air over the lower surface, buoying the animal up—none of this air has any relation to the mechanics of respiration.

Gyrinids fly well, but must launch themselves from some object above the surface film—they appear incapable of flying up directly from the water.

ADULTS

Important genera are (Leech 1948):

1. Last apparent abdominal sternite elongate, conical, pubescent along median line; scutellum not visible; small species, about 5 mm. . . . . (Gyretes)
—Last sternite broader and flatter, not conical, not pubescent along median line; scutellum visible or not; size variable. . . . 2

2. Scutellum visible; elytral striæ punctate; smaller species, 4.5-8.0 mm. . . . . GYRINUS
—Scutellum invisible; elytral striæ not punctate; larger, broader species, 10-15 mm. . . . . (Dineutus)

LARVÆ

1. Head subcircular with collum narrow and distinct; mandible falcate without retinaculum (lateral abdominal filaments not plumose) . . . . (Dineutus)
—Head elongate with collum about as wide as rest of head and not distinct; mandible with retinaculum. 2

2. Nasale without teeth. . . . . (Gyretes)
—Nasale with 2-4 teeth in a transverse row (lateral abdominal filaments all plumose) . . . . GYRINUS

GYRININI

GYRINUS Geoffroy 1762

GYRINI OF NEVADA AND ENVIRONS
(Fall 1922A)

1. Venter entirely metallic black. 2
—Not. 3

2. Strial elytral punctures much larger at sides than near the suture; the lateral stria canaliculate. . . . . . (*parcus* Say 1834)
—Punctures less evidently larger laterally, frequently scarcely at all so; lateral stria not or scarcely impressed. . . . . (*picipes* Aubé 1838)

3. Venter, including hypomera and epipleura, testaceous or ferruginous 4
—Venter metallic black, hypomera and epipleura testaceous or rufous 7

4. Dorsum finely alutaceous and minutely punctulate, more noticeably so in the female. . . . . *bifarius*
—Dorsum highly-polished, and either not at all alutaceous or punctulate, or only visibly so under high magnification. 5

5. Ventral color nearly uniform, the surface without trace of microsculpture in either sex.......(*plicifer* Le Conte 1852)
—Venter normally darker medially than along margins......6

6. Sides of ventral segments bright rufous, contrasting sharply with the dark median area; northern.........*maculiventris*
—Sides merely brownish, little differentiated from the darker medial area ....*consobrinus*

7. Surface in both sexes micropunctulate and minutely alutaceous .... *pleuralis*
—Surface in both sexes thickly covered with very fine, short, oblique striolæ........................(*affinis* Aubé 1838)

G. CONSOBRINUS Le Conte 1852. Washoe County (*Truckee Meadows*) (Reno) 14/IV/39, el. 4500 ft. -LaR). Common, at least in western Nevada. Originally described from San Francisco and San José (California) specimens. In addition, specimens in the California Academy of Science collection bearing labels "Bijou, Lake Tahoe, 21/VII/21, Blaisdell" indicate an additional Nevada area where collecting will undoubtedly produce the species.

G. BIFARIUS Fall 1922. In his original description, Fall listed Paris, Maine as the type locality and mentioned "Nevada" in a long list of localities extending from coast-to-coast. I have no specimens.

G. PLEURALIS Fall 1922. Washoe County (*Truckee Meadows* (Reno) 14/VII/40, 18/VIII/40, el. 4500 ft. -LaR). The commonest western Nevada species. The types were collected by H. F. Wickham at Laramie, Wyoming.

G. MACULIVENTRIS Le Conte 1868. Elko County (*Ruby Valley*, C. T. Brues, 1927—Hot Spring No. 28 (33.0°C, sp. gr. 1.0009, pH 9.4) (Brues 1928). I have no specimens.

There are specimens of *Gyrinus affinis* in the California Academy of Sciences collection from "Bijou, Lake Tahoe, 21(vii)21, Blaisdell," just across the Nevada-California state line.

Wilson (1923) furnishes the following compendium of biologic information on Gyrini. He had two species in the Fairport, Iowa fishponds, *G. ventralis* Kirby 1837 and *G. limbatus* Say 1823, neither of which bred in the ponds but adults were common there.

The eggs are laid in rows on the leaves or stems of water plants. Larval Gyrini swim like Dineutes "with a sinuous motion of the whole body up and down after the manner of a flatworm. There are no swimming fringes on the legs, but instead the eight posterior pairs of lateral gills are heavily fringed on both sides, and thus serve for locomotion as well as for breathing. By lashing them up and down the larva can move either forwards or back-

wards with great rapidity.......According to Miall......'The Gyrinus larva feeds upon water insects and possibly upon other aquatic animals. Failing these it will eat the tender parts of submerged plants.' According to Needham the larvæ also 'feed upon the body fluids of bloodworms and other small animal prey.' It is difficult to understand how a larva like this, whose mouth parts are typically carnivorous, and whose mandibles are suctorial like those of the Dytiscidæ, can eat vegetable food as stated by Miall."

Since *Dineutus* is a possibility for southern Nevada, and because of the general paucity of such information in print, Wilson's notes on *D. americanus* Say 1826 are pertinent (1923):

"The eggs were found in clusters varying from 7 to 40 in number on the under surface of the leaves of *Potamogeton illinoensis* in pond 2D. They were white in color and were arranged diagonally at an angle of 45° with the mid rib of the leaf, all on one side near the base. They were regular elongated ellipsoids, 1.85 mm. long and 0.64 mm. wide . . . The larva is folded lengthwise inside the eggshell in the same manner that the mature larva afterwards folds itself inside the pupal chamber.

"When the egg hatches, the shell splits lengthwise on the bottom through the space uncovered by the prismatic layer from end to end. The larvæ all hatch at about the same time and crawl around on the surface of the leaf amongst the empty eggshells for several hours before swimming away. The hatching occurs five or six days after the eggs are laid.

"As soon as it is once straightened out the newly hatched larva is from 5 to 5.5 mm. long, and the head, which is the widest part of the body, is 0.75 mm. in diameter. This larva is like the fully matured one, except that the prothorax is as wide as the mesothorax and metathorax, and the first two pairs of lateral gills are plumose like the others."

The swimming motion is as described above under *Gyrinus*. In addition: "On the land it crawls quite rapidly; being unable to lift the posterior part of the abdomen above the ground, it aids locomotion by using the last segment with its hooks like the posterior prolegs of the caterpillar, arching the abdomen upward like the so-called inchworm. It can also jump quite a distance by snapping its body in the same manner as the Thermonectes larva. When two larvæ come together out of the water, the first instinct is self-preservation, and each jumps back as far as it can.

"In an aquarium the larva rests nearly always on the bottom and not on the water plants, and the abdomen maintains a constant trembling motion up and down, which is evidently its mode of breathing. Hence, it never needs to come to the surface for an air supply.

"It is not voracious but will defend itself fiercely when attacked and will catch anything that is unfortunate enough to

crawl against it. . . It shows a preference for the nymphs of damselflies and mayflies and the larvæ of Corethra and Chironomus.

"When the larva is full grown, it crawls out of the water and up on the bank, and its lateral gills shrivel up and fall off, except the last double pair and the single pair just in front of them, which are also used for locomotion. The distance traveled and the place finally selected appear to depend upon the moisture of the earth, which must be soft enough to be easily worked but not moist enough to be muddy. The larva is quite particular in its choice and often covers a considerable area before finding a location that suits it.

"Then there must be a convenient support to which the pupa case may be attached. The under surface of a dead grass or rush stem was usually chosen, since it was near enough to the ground for the larva to reach after building material and at the same time far enough removed to give the space requisite for the completed case. The case is made of pellets of earth stuck together with saliva. The earth apparently is not chewed and thoroughly mixed with the saliva after the manner of the mud wasps; rather, a mouthful of material is seized by the mandibles, wet with saliva, and pressed into place, and there is no smoothing of the outside surface or shaping by the mandibles. The outside of the case is rough, but the curve of the walls is quite regular. Sand grains, small fragments of rock, bits of wood, and pieces of leaves are mixed with the mud pellets in the walls. The larva clings to the grass stem with its posterior hooks and constructs the case around its own body. When the case is finished, except a small orifice at one end, the larva transfers enough material to the inside of the case and completes it from there. The case is 13 to 16 mm. long, 8 to 10 mm. wide, and is usually a fairly regular ellipsoid. The walls are about 1 mm. in thickness, except at the ends, where it is increased to 2 mm. A full-grown larva is about 30 mm. long, and hence its body must be folded inside the case; it assumes the form of the letter C, the ventral surface inside. After resting two or three days the skin splits open along the dorsal mid line from the base of the head to the ninth abdomen segment and flattens out against the inside of the case."

ENHYDRINI

The two species of *Dineutus* of nearby southern Arizona and California have been keyed by Leech (1948):

Length 12-15 mm.; forefemora of males with a small tooth at apical three-fourths, on lower anterior margin; apex of median lobe of male genitalia dorso-ventrally flattened, apices of parameres sub-acute (Subgenus *Dineutus*)................ ....(*sublineatus* (*Chevrolet*) 1833)

Length 9-10 mm.; male forefemora without a small tooth at apical three-fourths on lower anterior margin; apex of median lobe distinctly arched, not flattened, apices of parameres broadly round (Subgenus *Cyclinus*) (*solitarius* (Aubé) 1838)

ORECTOCHILINI

(*Gyretes* Brullé 1834)

G. californicus Regimbart 1907 and *G. sinuatus* Le Conte 1852 are known from extreme southern California to Texas, and are not likely possibilities for Nevada.

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Published by the Academy at Los Angeles, California
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Vol. XLVIII, 1949

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